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IN MEMORIAM PROF. DR. BÉLA FARKAS

Béla Farkas wurde am 15. Juni 1884 zu Hajdúnánás geboren. Die Grundschule und die ersten sechs Klassen der Mittelschule besuchte er in seiner Geburtsstadt, die beiden letzten Gymnasialklassen aber bereits in Klausenburg, wo er auch die Reifeprüfung ablegte und die Universität absolvierte. Bereits in jungen Jahren wird er Assistent von Professor István Apáthy in dem schon damals weltberühmten Zoologischen Institut in der Mikó-Gasse in Klausenburg. 1914 befindet er sich bereits in Neapel, wo er am Ungarischen Tisch des dortigen Institutes für Meereskunde arbeitet, wo auch sein Meister sich so wohl fühlte, und — ausser seinen Laboratorien in Klausenburg — am liebsten arbeitete. Béla Farkas wird schon vor dem I. Weltkrieg durch seine histologischen Utersuchungen bekannt.

Nach dem I. Weltkrieg — im Anschluss an den Imperiums-Wechsel Siebenbürgens — repatriiert er mit zwei Eisenbahnwagen voll Laboratoriumseinrichtungen aus Klausenburg nach Budapest. Hier richtet er im Gymnasium-Gebäude in der Szegényház-Gasse provisorisch das geflüchtete Zoologische Institut ein. Sein Meister befindet sich zu dieser Zeit in rumänischer Kriegsgefangenschaft in Siebenbürgen, und so ist es zum grossen Teil das Verdienst von Béla Farkas, dass ein Jahr später im Gymnasium an der Kleinen Ringstrasse in dessen erstem Stock — an der nach Szeged übergesiedelten Universität unter bescheidenen Verhältnissen der Zoologie-Unterricht beginnen konnte.

István Apáthy, — aus der Gefangenschaft entlassen — nimmt den Lehrstuhl für Zoologie ein und unterrichtet hier an der Universität Szeged bis zu seinem Tode in der zweiten Hälfte des Jahres 1922. Sein durch die vielen Leiden zermürbtes Herz macht seinem Leben früh ein Ende. An seinem Grabe halten Béla Farkas und Verfasser dieser Zeilen — als sein jüngster Schüler — die Abschiedsrede auf dem Szegeder Friedhof, wo jetzt schon die Gebeine von Meister und Schüler gemeinsam ruhen.

Der leergewordene Lehrstuhl wird vorläufig von Béla Farkas geleitet, später wird er aufgeteilt: in einen Allgemeinen und einen Systematisch-Zoologischen Lehrstuhl, an dem ersten unterrichtet Joseph Gelei und am zweiten Béla Farkas — bereits als Professoren, beide Schüler Apáthy's.

Von seinen bisherigen histologischen Studien wendet sich Béla Farkas jetzt der physiologischen Richtung zu, er beschäftigt sich mit dem Gehör der Fische. Er hält sich wiederholt im Auslande auf, nimmt an lebhaften Debatten teil und lässt dem Systematisch-Zoologischen

Institut im neuen Gebäude am Ady-Platz stets weitere Entwicklung angedeihen. Einer der letzten Wünsche Apáthy's war, den Schreiber dieser Zeilen zum Zoologen auszubilden — und siehe, Professor Béla Farkas hat darüber hinaus auch noch zwei weitere Privatdozenten qualifiziert und der Ungarischen Zoologie mehrere, auch heute vorzüglich wirkende Universitäts-Doktoren erzogen.

Nach dem II. Weltkriege wird er pensioniert. Er nimmt noch an einem Landes-Apáthy-Symposium — organisiert von Professor Ferenc Kiss und dem Schreiber dieser Zeilen — teil und im Jahre 1957 wird ihm auch der Titel eines „Doctor acad. biol." verliehen. Bis zu seinem am 19. März 1967 eingetretenen Tode hat er in seinem stillen Heim in Szeged Untersuchungen durchgeführt und an seinem letzten Manuskript gearbeitet. Der Tod hat uns in ihm den letzten Assistenten seines grossen Meisters entrissen, er hat uns verlassen und nun sind bereits alle Leiden, aber auch die Erfolge und der wissenschaftliche Ruhm der einstmals so produktiven, aber ausserordentlich kampfreichen Apáthy-Aera zu einer Erinnerung, einem Andenken veredelt.

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FOUR ARCHETYPES OF THE LIVING AND FOSSIL TREES

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(Received June 10, 1967)

In recent times more and more number of relicts of plants from bygone geological periods are found in the depth of Earth or sometimes even on its surface. They are sometimes found but in small shreds; sometimes, however, larger pieces of more developed terrestrial plants, and even the trunks of huge fossilized woods or their pieces got before the pickaxes of miners. Several branches of science like, first of all, paleontology, phylogeny, taxonomy, phytogeography, climatology, geology, and sometimes even petrography want to know under which conditions these ancient plants may have lived before many hundreds of thousands or millions of years, and what kind of possible catastrophes sank the forests of the former mainlands into the depth of Earth sometimes several hundred metres deep. As these former terrestrial plants, in their individual life, had some particular organisation and structure preserving them in the depth of Earth during the millions of years in the same way as those living to-day, so the different branches of science can ascertain far-reaching scientific and practical relations from these fossilized relicts comparing them with those living to-day.

The relicts of former woody plants from the geo-historical past have remained in highly different states of continuance till our days. As a consequence of the different geological, climatological or chemical influences they have sometimes become fragile, mouldering; on other occasions, on the other hand, they became siliceous, carbonized or calcified, shortly they have got fossilized. They could be strongly deformed, often even in their original shape, during the different fossilizing and chemical processes as influenced by the pressure of the several layers; thus we can make sure of their original finer structure only with more exact examinations, first of all by the help of plant anatomy.

The whole present surface of our Earth, and the terrestrial areas of ancient ages, as well — at least since the Carboniferous period about 300 million years ago — has become populated only with four sorts of tree types. In this respect the oldest ones are the *Gymnospermae* as the

Cycas-types, much more wide-spread in the middle-ages of Earth, beside the *Coniferae*. In the middle-ages of Earth there appeared the two types of *Angiospermae*, the *Monocotyledones* and *Dicotyledones*. Each of these four types has such a particular internal structure, anatomy, differring so much from each other, that they can be separated easily even in fossil form. The internal structure of these existing four types of trees is demonstrated by the photographs Nos. 1, 2, 3 and 4. What are the anatomical peculiarities of these four archetypes of trees, separately, on the basis of which we can exactly ascertain to what tree type one or the other fossilized wood relict belonged in older times?

(1) *Cycas-type.* If in the cross-section after the central developed pith (1) one or two woody (6) and inner bark rings (7) follow, if in pith and bark (8) major mucilage canals pass (8) while in the woody part pith rays of one or more seriate (4), and in the pith rays conductive bundles (14), then a piece of trunk like that could only originate from some sort of *Cycas*-type trees (Plate 1).

(2) *Coniferae-type.* If in the sectional picture the cross-sections of the single elements (tracheids) are equal in size and arranged in radial direction close to one another in regular lines and annual sectors, if among these woody elements there are passing in radial direction pith rays of a width of one cell layer or two, and in the tree-body possibly resin-passages, as well, so from a structure like that a sure consequence can be drawn to a kind of *Coniferae* (Plate 2).

(3) *Palm-type.* If in the basic substance of the cross-section there are scattered larger cell groups, or more exactly, collateral closed vascular bundles, and if there aren't in the tree either annual rings or pith rays, then that fossil must have been some monocotyledonous woody plant generally a sort of palm type (Plate 3).

(4) *Dicotyledonous-type.* And if in the sectional picture beside the minor cavities there are much larger cavities, as well, — the cross-sections of vessels — arranged in the basic substance irregularly or regularly alone or in smaller or larger groups, and if in the tree there pass annual rings, as well as pith rays of radial direction with one layer or more, so we have to think unconditionally on the basis of that structure on some sort of *Dicotyledones* (Plate 4).

The sectional structures of these four archetypes of trees are demonstrated in Figs Nos. $1a^b$, $2a^b$, $3a^b$, $4a^b$.

We generally begin a determination of an unknown sort of living trees or fossils by investigating the cross-sections, because if the sectional structure of a living or fossilized tree is known then the original result may already give valuable informations for the further investigations carried out more exactly and in details till the final determination of the sort of tree (Cf. the explaining texts of Photographs).

It is anyway natural that inside the single types of trees the variety is extremely great; nevertheless, on the basis of their entirely peculiar anatomical marks, the single sorts or families can be separated and well determined. The four type marks are unchanged in each of the species separately, highly facilitating the separation and determinaton of the single fossilized trees.

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PLATE I

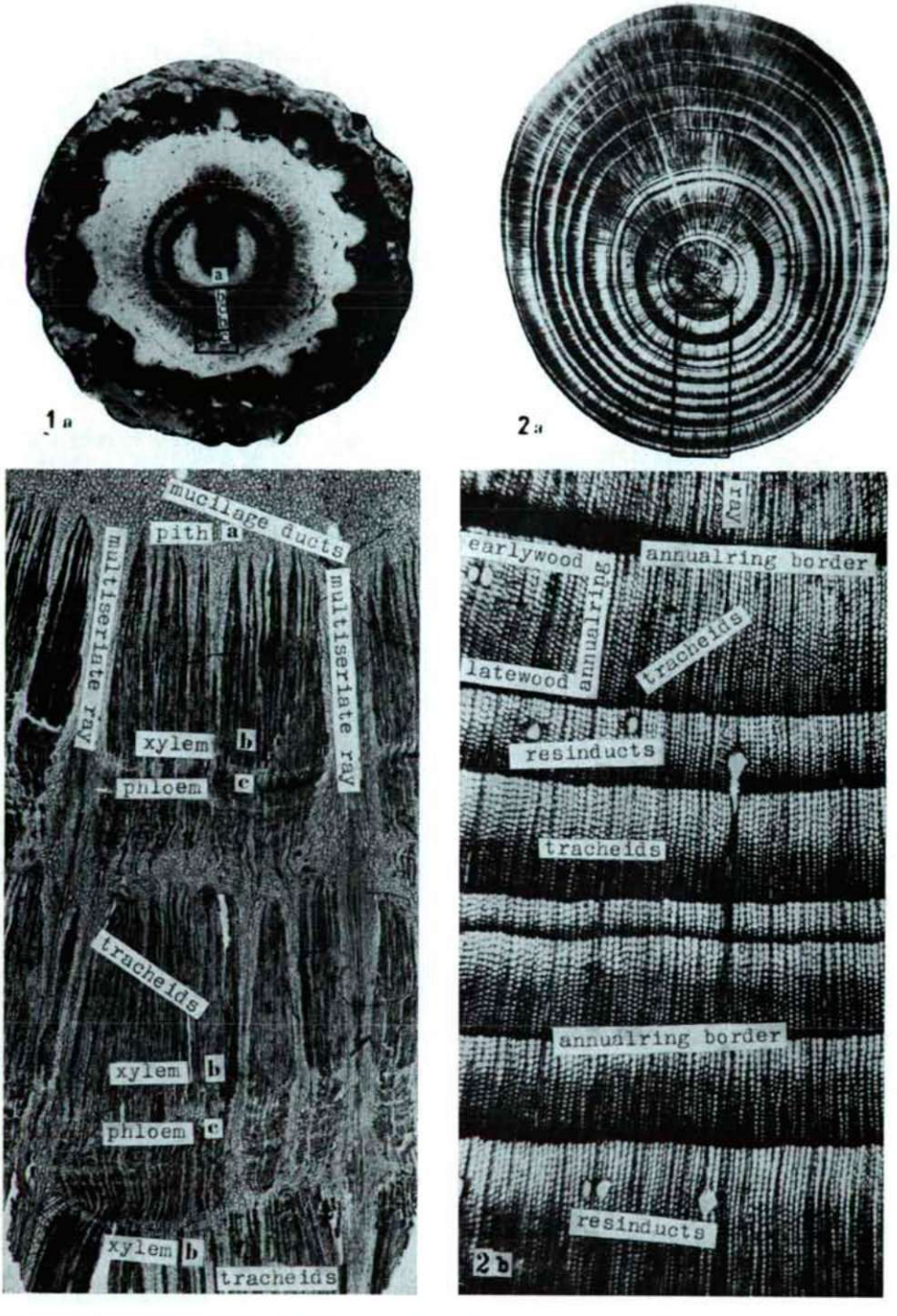

Plate I. Fig. 1a Cross section of *Cycas revoluta* 1/2 nat. size, a) pith, b) xylem part, c) phloem part. 1b. Internal structure of conductive bundles, (x15). 2a. Cross section structure of a 12-years old twig of spruce *(Picea)*. 2b. Anatomical cross structure of the spruce (x30). (Original)

PLATE II

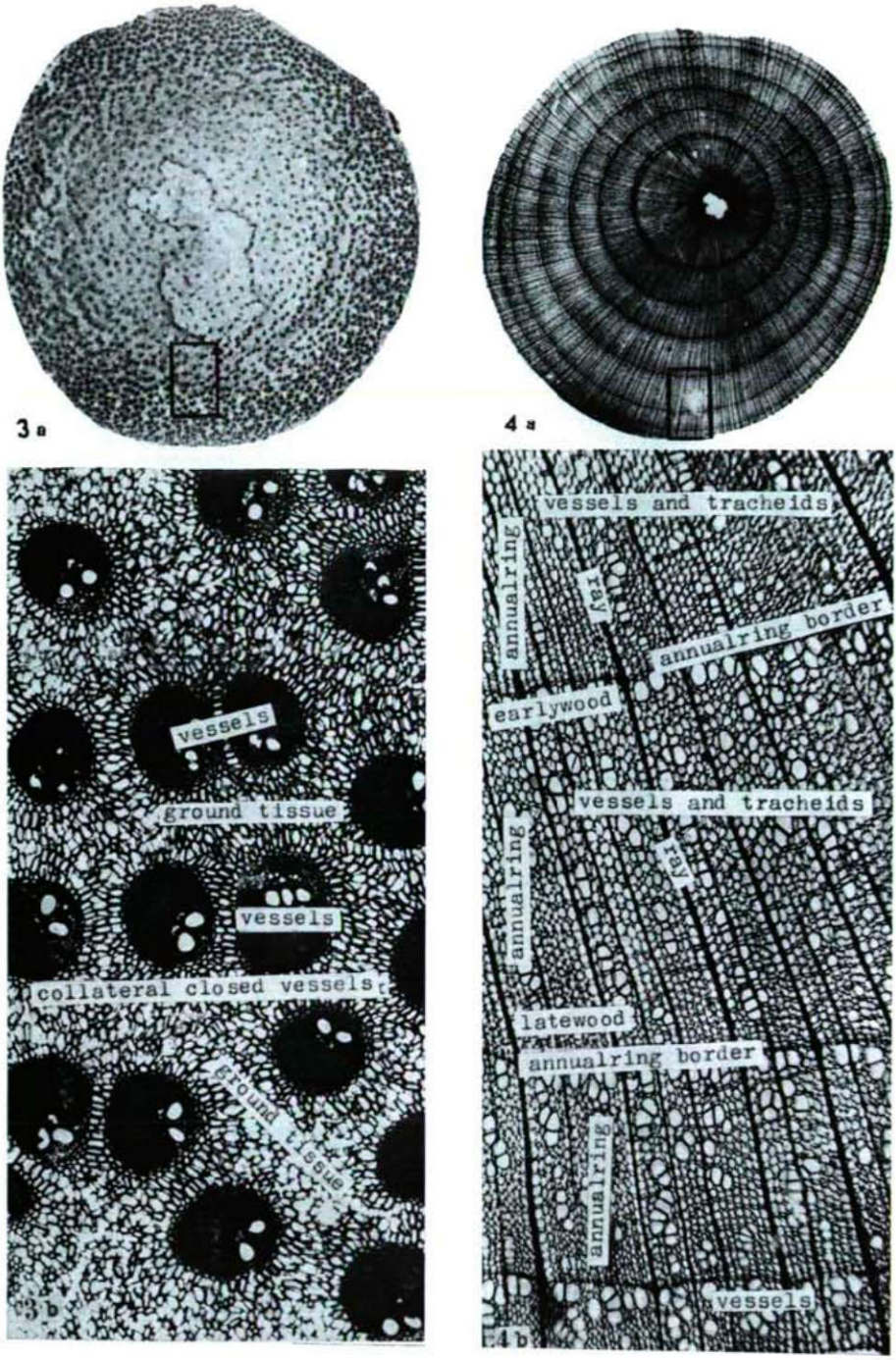

Plate II. Fig. 3a. Cross section structure of a palm stem *(Raphis,* x2). 3b. Anatomical structure of a palm stem (*Raphis,* x30). 4a. Cross section structure of a dicotyledonous tree. (*Tilia* x5). 4b. Anatomical structure of a dicotyledonous tree *(Tilia,* x5). (Original)

PLATE III

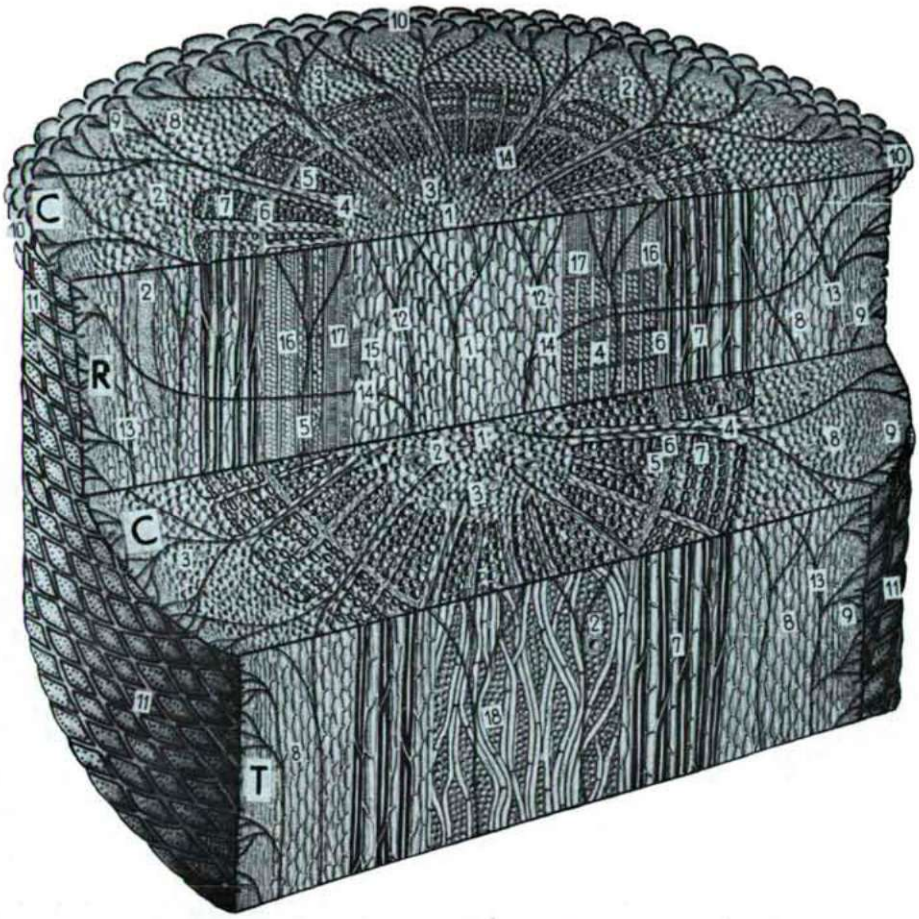

Plate III. *Schematic drawing of a Cycas stem in three planes of section.* C = cross section, R = radial section, T = tangential section. 1. Pith, 2. Mucilage canals, 3. Calcium oxalate druses, 4. Primary ray, 5. Xylem part. 6. Cambium, 7. Phloem part, 8. Cortex, 9. Periderm, 10. Vestiges of leaf bases, 11. Leaf scars, 12. Pith bundles, 13. Bundles in the cortex are passing out to the leaf bases, 41. Common bundles are passing out through the primary rays into the leaves, 15. Transfusion cells, 16. Tracheids with araucaroid pitting, 17. Tracheids with scalariform thickening, 18. Multiseriate rays. (Original, Greguss and Havas).

PLATE IV

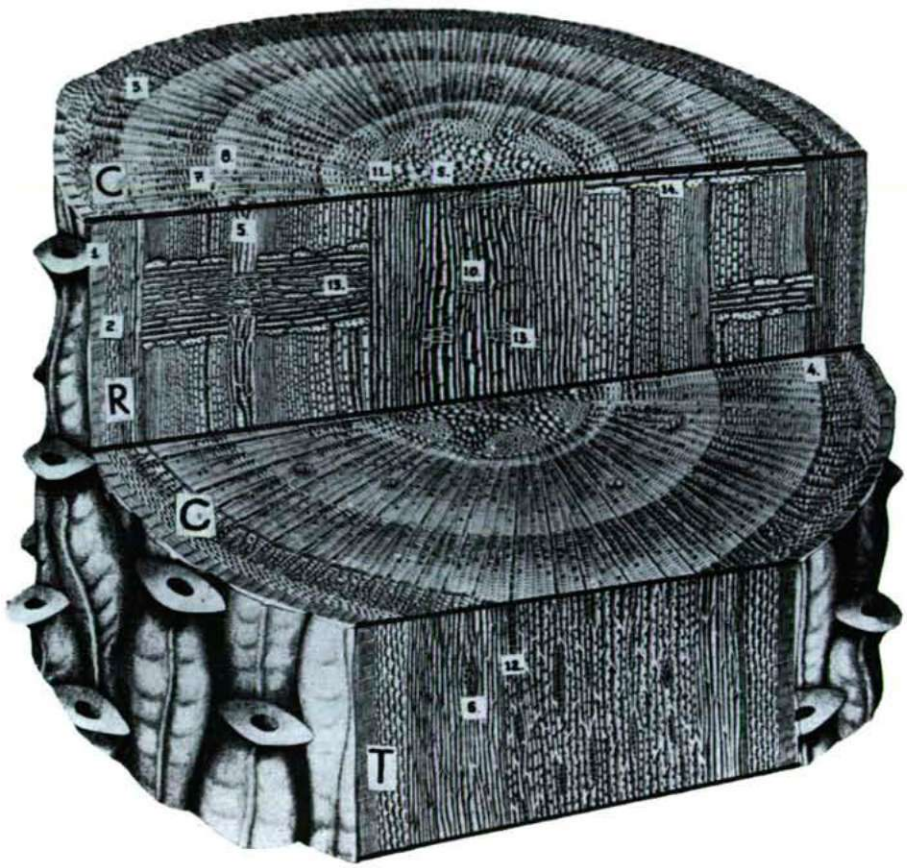

Plate IV. *Schematic drawing showing the wood of a 3-years old spruce (Picea)* twig in three planes of section. C = cross section, R = radial section, T = tangential section. 1. Epidermis. 2. Periderm. 3. Phloem. 4. Cambium. 5. Vertical resin duct. 6. Horizontal resin duct. 7. Earlywood. 8. Latewood. 9. Pith. 10. Pithsclerenchyma. 11. Primary wood. 12. Medullary ray (seen in tangential view). 13. Thick-walled ray cells. 14. Marginal cells, transverse tracheids. 15. Tnick-walled epithelial cells. (Original, Greguss and Gosztonyi).

PLATE V

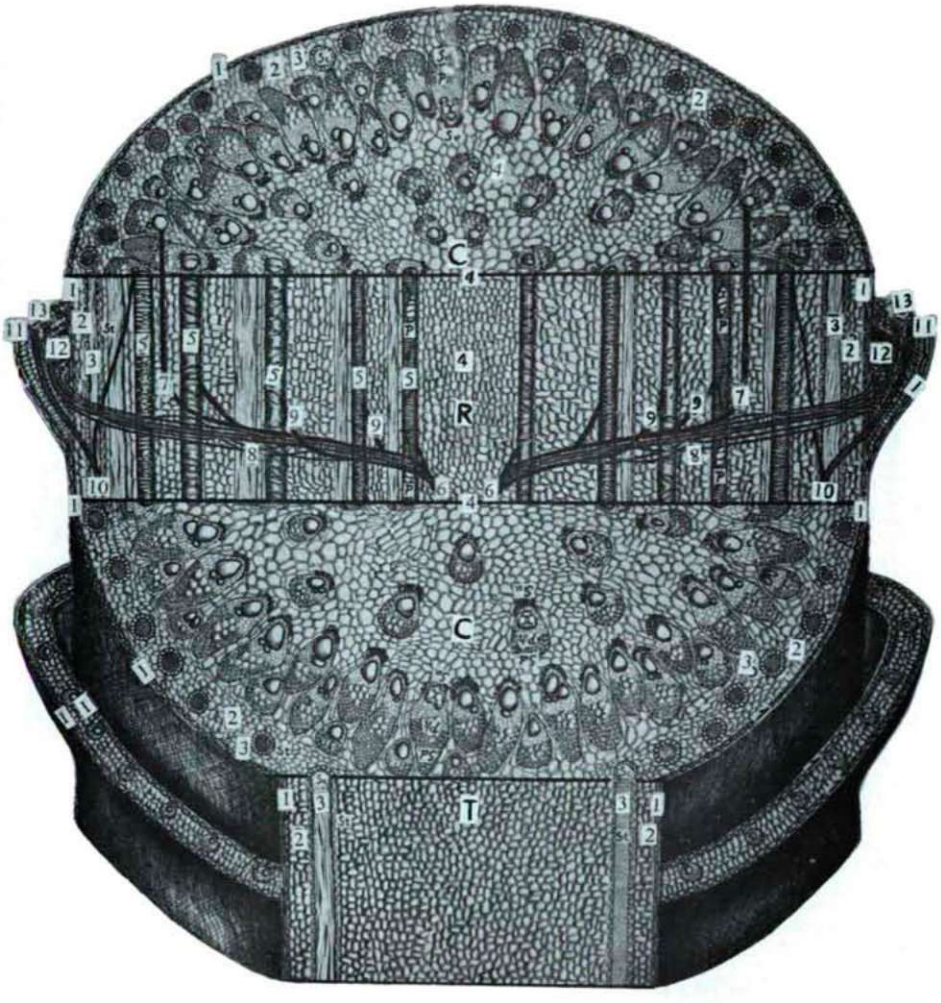

Plate V. *Schematic drawing showing the wood of a palm stem (Raphis) in three planes of section.* C = Cross section, R = radial section, T = tangential sections. *Cross section,* 1. Epidermis on the stem and in the leaves. 2. Parenchyma cells of the cortex. 3. Sclerenchymatous fibres (Sc) with stegmata (St). In the ground tissue the vascular bundles are sporadic. The part of the vessels: X = Xylem, Ph = phloem, Sd = dorsal sclerenchyma, Sv = ventral sclerenchyma. *Radial section.* On the side of the stems there are two leaf bases. Upper and lower epidermis (1—1). In the middle there is the mesophyll. The sclerenchyma fibres are with stegmata. The veins are going in the leaves. In the vascular bundle there are vessels with scalariform and spiral thickenings. (5). At P = perforation. The black and hachured line shows the running of the vessels. (6). From the mark spall the big bundles on the one side the vertical bundle (7—7) into the satellite bundle (8), after into the bridge, and go out in the leaves (11) and in the cortex. (7). In the the outercortex come little bundless (10) from under (towards) as upwards and pass out as leafbase bundles in the leaves. *Tangential section.* 1. Epidermis, 2. Cortex parenchyma, 3. Sclerenchyma fibres (Sc) with stegmata. (Original, Greguss and Meskó—Bóka)

PLATE VI

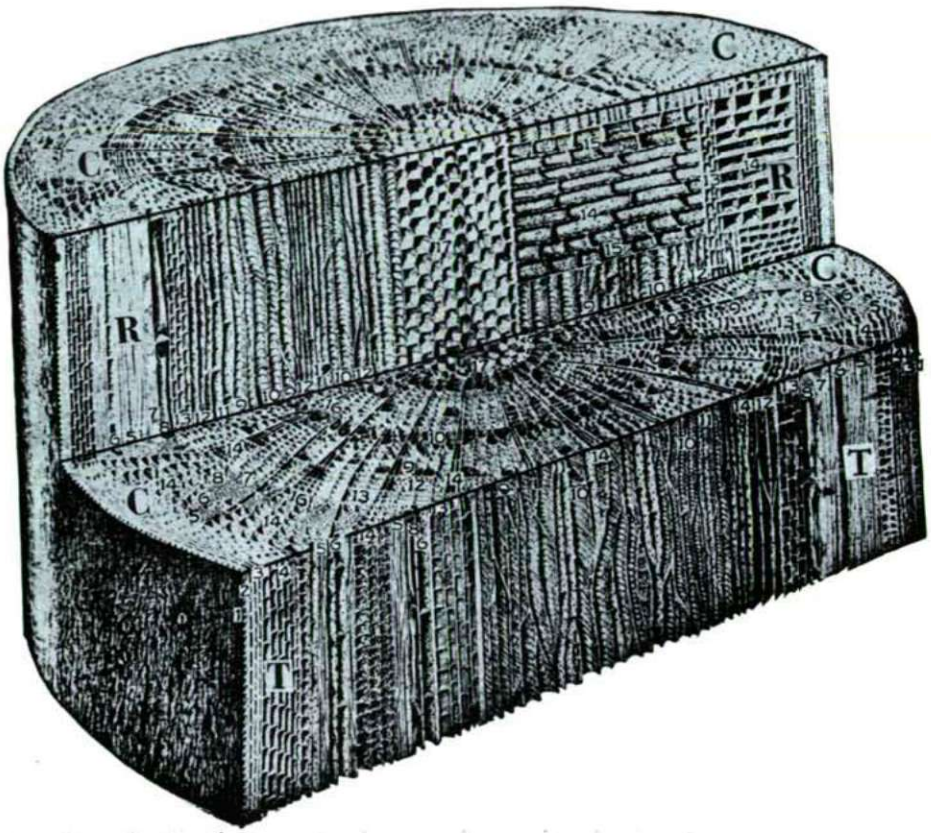

Plate VI. *The internal structure of a two years old twig of lime-tree (Tilia).* C—C = Cross section, R—R = radial section, T—T = tangential section. 1. Cuticula. 2. Epidermis. 3. Bark 4. Bast. 5. Bast fibres. 6. Bast parenchyma cells. 7. Companion cells. 8. Sive tubes. 9. Tracheids. 10. Vessels. 11. Wood-parenchyma cells. 12. Fibre tracheids. 13. Cambium. 14. Rays. 15. Ray-edge cells. 16. Annularing border. 17. Pith (Original. Greguss and Tóth).

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THE RECYCLED SPOROMORPHS OF THE BORING NO. NY-1 IN KECSKEMÉT

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(Received July 21, 1967.)

Introduction

The boring under examination was surrounded at its deepest site by Sarmatian and Tortonian layers proved by the fauna, and it has come to a stop in a depth of 2127 m in Tortonian layers. According to B. Molnár's oral information, geologists suppose on petrological basis a recyling of an age older than the Tertiary period, and consider the whole material to be possibly reworked. As referred to by Wilson (1964), and as expressed in a former publication by us (Kedves, Endrédi and Szeley 1966), in the Hungarian relations, the palynological method is highly suitable to illuminate the conditions of reworking, therefore we have considered useful to investigate the layers in question. Obtaining the material for our research work from Dr. Mária Miháltz-Faragó, we wish to express her our thanks for her so kind help in this way, as well.

Material and Method

On the basis of geological period determination, we have investigated one sample from the Sarmatian layers (1931,0—1933,0 m), and four ones from the torton layers (1968,0—1970,0; 1005,5—2004,5; 2096,0—2098,0; 2121,0—2125,0 m).

Results

The samples examined are generally rich in sporomorphs, reffering to the middle Tertiary period. The number of the sporomorphs recycled is small. As the assemblage of the reworked forms is by and large the same in every sample, the demonstrated secondary sporomorphs can be summarized as follows:

Zonalasporites fsp.$_1$
Zonalasporites fsp.$_2$
Ovalipollis cf. *rarus* Klaus 1960
Pityosporites cf. *illustris* Leschik 1955
Pityosporites devolvens Leschik 1955
Lunatisporites acutus Leschik 1955
Vitreisporites fsp.
Parcisporites fsp.
Platysaccus fsp.
Scopulisporites fsp.$_1$
Scopulisporites fsp.$_2$
Tricolpites (Eucommiidites) troedssonii Erdtman 1947.

Two *Hystrichosphaeridae* types (A, B) are referring to saltwater origin, and also a *Peridinium* sp. of a probable sea ecology has been observed.

Discussion

About Hungary there are but comparatively few paleo- and mezozoic palynological publications. Therefore, the age of being reworked can be indicated only approximately on the basis of the sporomorphs recycled, being anyway very few in number.

The observed secondary assemblage is separated well from the assemblages arising from the period between the upper Permian and the upper part of middle Triassic published from boring No. 1. Mesteri (Juhász, Kővári, Kriván-Hutter and Majzon 1964) and the upper part of the middle Trias period, as well from the Permian-Triassic assemblage in Solymár (Kedves 1965 c). It is difficult, as well, to identify it with the younger assemblage of the Triassic period, first of all with the spore-pollen assemblage described by Venkatachala and Góczán (1964) from the Bakony mountain. In connection with this, the complete lack of the families of the *Operculati* group *(Classopollis, Circulina, Granuloperculatipollis)* is conspicuous. It is interesting that the most types are similar to the assemblage from the Keuper period published by Kräusel and Leschik (1955). On the otherhand, it is separated well from the sporomorph assemblage from the Liassic period known from the publications of Góczán (1956) and Bóna (1963).

On the basis of a comparison with the forms of Kräusel and Leschik (1955), the age of recycling can be fixed in the Trias, more close in the upper part of Trias. It differs from the sporomorph assemblage recycled and formerly published from the area of the Great Hungarian Plain (Kedves, Endrédi and Szeley 1966) first of all by the fact that, in the present case, the recycling is simple while in the borings at Macs, Kemecse, Szentes and Makó a complex recycling could be ascertained. The lack of spores, unaccustomed opposite to the observations so far, is very interesting and obvious. From this fact the conclusion can be drawn that the transferred sediment was far from

the zone of the littoral vegetation. A comparison with the transferred forms, discussed in the former paper, from the Triassic period is rather difficult because of the poverty of the assemblage, it is similar anyhow, in some degree, for the most part to the type known from the surroundings of Macs and Kemecse.

Summary

The recycled spore pollen assemblage of five samples from the lower site of the boring No.Ny.-1 in Kecskemét has been investigated. On the basis of our results, it can be ascertained as follows:

1. The recycling is simple, only sporomorphs from the Triassic period could be observed among the sedimental autochtonous sporomorphs.

2. From the lack of spores in the secondary sporomorphs the conclusion can be drawn that the zone of the transferred sediment was far from the coastal line.

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EVALUATION OF THE SPORE-POLLEN ASSEMBLAGE OF THE BAUXITE IN GÁNT

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(Received July 21, 1967)

Introduction

The first data about the pollen examination of the bauxite in Gánt containing plat relicts were published with description of the zonotrilete spores in 1965. In this paper further results of the examinations upon this sediments are published.

Results

Pteridophyta
Tmesopsida
Psilotales, Psilotaceae. — *Microfoveolatosporis pseudodentatus* W. Kr. 1959 b.
Pteropsida
Leptosporangiatae
Filicales, Polypodiaceae. — Verrucatosporites alienus (R. Pot. 1931 c) Th. and Pf. 1953; Verrucatosporites favus (R. Pot. 1931 c) Th. and Pf. 1953 subfsp. favus; *Polypodiidites secundus* (R. Pot. 1934 b) W. Kr. 1963. subfsp. *secundus.*
Gymnospermatophyta
Coniferopsida
Pinales, Abietaceae, Pinoideae. — *Pinus haploxylon* type — *Pityosporites microalatus* (R. Pot. 1931 b) Th. and Pf. 1953; *Pinus diploxylon* type — *Pityosporites labdacus* (R. Pot. 1931 b) Th. and Pf. 1953.
Abietoideae v. *Laricoideae* — ? *Pseudotsuga*, ? *Larix* — *Inaperturopollenites* cf. *magnus* (R. Pot. 1934 b) Th. and Pf. 1953. (The forms under this name represent, for the present, a heterogeneous group. Also fresh-water plankton organisms may, possibly, have a role besides pollens of conifera, and even spores of *Equisetum* can conditionally be thought of).

Taxodiaceae v. *Cupressaceae.* — *Inaperturopollenites* cf. *dubius* (R. Pot. and Ven. 1934) Th. and Pf. 1953.

Angiospermatophyta

Dicotyledonopsida

Polycarpicae-Rubiales

? *Magnoliales,* ? *Magnoliaceae.* — *Ovoidites* cf. *microligneolus* (R. Pot. 1931 d) W. Kr. 1959 b. It is an extremely problematic type of microfossils, frequently mentioned in literature as a vegetal or animal planktonic or benthonic organism.

Myrtales, Nyssaceae v. Mastixiaceae. — *Tricolporopollenites* cf. *kruschi* (R. Pot. 1934 b) Th. and Pf. 1953.

Caryophyllales — *Monochlamydeae*

Fagales, Fagaceae. — *Tricolporopollenites oviformis.* (R. Pot. 1931 a) Th. and Pf. 1953.

Juglandales, Juglandaceae — *Engelhardtia* — *Triatriopollenites* fsp. Cf. *Juglandaceae.* — *Subtriporopollenites* fsp.

Monocotyledonopsida

Monocolpopollenites fsp.

Apart from spores and pollens, we have observed the relicts of several planktonic organisms.

Discussion

From the bauxite patterns examined, the bauxite with vegetal remains was the richest in microscopic relicts. In the course of our investigations, we could not observe any fossils demonstrating salt-water conditions.

In comparison with the palynological results of bauxite sediments or those covering it, known so far from the area of Transdanubia, the following can be ascertained:

1. The bauxite overlying of Halimba (H. Deák 1957, 1960, Kedves 1961 c), the oldest one, belongs, even on the basis of recent comparative investigations (Kedves 1967 a), into the lower part of the Cuisian.

2. The bauxite overlying of Iszkaszentgyörgy (Kedves 1962 d, f, 1965 e, Kedves and Endrédi 1965) is a younger formation than the former one, but it still represents the upper part of the lower Eocene.

3. We consider the spore-pollen assemblage of type Gánt a younger formation than the former ones. This is supported by the following:

a) A complete lack of the polyanulate myricoid, the tri- and subtriporate pollens of older type, the *Interpollis* fgen., generally of the *Normapolles.*

b) Similarly, there is a lack in tropical elements *(Palmae, Schizaeaceae,* etc.) which were characteristic of the lower part of the middle Eocene in this country.

c) In the spore pollen assemblage in Gát the pollens of air-pocket type are of considerable number: that is — as we know so far — characteristic of the upper part of Eocene or the top of the middle Eocene.

Thus, in contradiction to the low Eocene bauxite in Halimba and Iszkaszentgyörgy, the examined material is, first of all, referring to the upper Eocene period.

Summary

Some palynological investigations have been carried out on the bauxite layers with vegetal relicts in Gánt.

1. In the relict assemblage examined the elements of subtropical character are dominating but also the number of taxons demonstrating a climate of temperate zones is considerable.

2. On the basis of the spore-pollen data, the patterns examined belong to the geological early upper Eocene or to the upmost part of the middle Eocene, being by no means older than those. On the basis of the palynological investigation of the bauxite layers, resp. the coverage of them, known so far, we are not informed about the formation of bauxite in the upper Cretaceous period (cf. H. Deák 1957, 1960).

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COMPARISON OF DELPINO AMENTIFLORAE ON THE BASIS OF THE STRUCTURE OF LEAF EPIDERMIS

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Introduction

For delimiting taxonomic categories and evaluating ecologic effects, there are often employed epidermal marks, as well. On the basis of the ontogeny of epidermal cells and subsidiary cells, the development, structure and shape of cuticles, the relief of leaf epidermis, stoma type and number and other epidermal marks, there is a possibility for defining species and separating them from one another (Bandulska, 1924; Sveshnikova, 1966; Sitte-Renier, 1963; Hluchvsky-Srb, 1959; Priestley, 1943; Linskens, 1966; Ujhelyi, 1960; Maácz, 1956; Greguss, 1962; Maróti, 1965, 1966; Gulyás, 1961; etc.).

„The organizational characteristics developed in the course of the evolutionary history of plant species refer — according to Soó, too — to a relationship of plants; on the other hand, the peculiarities in accomodation are determined by the essential external conditions, throwing light upon the way of life, ecology of plants" (Soó, 1945; Shenikov, 1953; Simon—Wolcsánszky, E.—Molnáros, 1964; Maróti, 1965).

During our examinations we have compared *Amentiflorae* from different soils on the basis of some measurable and formal marks of their leaf epidermis.

Material and method

At our examinations living and herbarial material was used. For preparation we have got samples from the middle part of the leaf-sheet of fully developed leaves to obtain a real comparison (Zalensky, 1904; Simon-Wolcsászky, E.—Molnáros, 1964).

The investigation of the epidermal structure took place on preparations made immediately, resp. on epidermis prepared by maceration (Sárkány—Szalai, 1966; Ujhelyi, 1954). Staining: vesuvin, acid haematoxylin Ehrlich-f, *Sudan* III, by triple staining (Kisser, 1926; Sárkány—Szalai, 1966).

For comparison the following measurable and formal features have been used: length and width of guard cells, the distribution of adjacent or subsidiary cells expressed in percentage, stoma count, L/W ration of guard cells, (their shape), type of stomata.

The measurement data are the average of 50 fields of sight. For demonstrating the formal peculiarities microphotographs have been applied.

The measurable features were evaluated by variancy analysis, F-test and t-test (Yule-Kendall, 1964).

The following species have been examined:

Ordo. **Urticales**

1. Familia: *Moraceae:*
   Morus alba L.
   Maclura aurantiaca Nutt.
   (Ioxylon pomiferum Raf.)
   Ficus elastica Roxb.

4. Familia: *Ulmaceae:*
   Ulmus laevis Pall.
   Ulmus glabra Huds. (Mill).
   Celtis occidentalis L.

Ordo. **Fagales**

1. Familia: *Betulaceae:*
   Betula pendula Roth.
   Beula nana L.
   Corylus avellana L.
   Corylus colurna L.

TABLE 1

Family	*Moraceae*			*Ulmaceae*			*Betulaceae*			
Species	*Morus alba*	*Maclura aurantiaca*	*Ficus elastica*	*Ulmus laevis*	*Ulmus glabra*	*Celtis occidentalis*	*Betula pendula*	*Betula nana*	*Corylus colurna*	*Corylus avellana*
Number of stomata piece/sq. mm	738	195	157	229	282	456	162	91	48	129
Length of guard cells in μ	13,8	27,4	39,6	29,2	30,5	21,9	30,5	40,5	32,1	27,1
Width of guard cells in μ	12,9	20,2	34,8	16,9	21,4	12,3	25,9	32,3	25,6	21,5
Ratio l/W of guard cells	1,06	1,32	1,07	1,67	1,34	1,74	1,34	1,19	1,19	1,19

2. Familia: *Fagaceae:*

Fagus silvatica L.
Quercus robur L.
Quercus prinus L.
Quercus rubra L.
Quercus macranthera Fisch et Mey.
Castanea savita Mill.

Ordo. **Juglandales**

Familia: *Juglandeceae:*

Juglans regia L.
Carya alba K. Koch.
Pterocarya fraxinifolia Spach.

Ordo. **Salicales**

Familia: *Salicaceae:*

Salix alba L.
Salix fragilis L.
Salix arbuscula L.
Populus alba L.
Populus canadensis Mnch.

Populus tremula L.
Populus balsamifera Dur.
(Soó, 1963)

Discussion of results

In Table 1 mainly home plant species, belonging to six families are compared. The leaves of the examined species are hypostomatic, except some species of the family *Salicaceae (Salix alba, S. fragilis, Populus canadensis),* therefore the Table is containing but data of the lower epidermis.

Fagaceae			*Juglandaceae*			*Salicaceae*				SD		
Fagus silvatica	*Quercus robur*	*Castanea sativa*	*Juglans regia*	*Carya alba*	*Pterocarya fraxinifolia*	*Salix alba*	*Salix fragilis*	*Populus alba*	*Populus canadensis*	0,1%	1%	5%
209	357	338	161	424	232	309	175	402	92	143	98	68
36,6	38,4	32,8	30,5	29,6	28,7	28,7	33,2	24,2	31,1	4,7	3,1	2,2
29,3	29,4	23,2	21,4	24,7	21,4	19,7	26,0	18,4	21,0	4,4	3,0	2,0
1,19	1,24	1,37	1,37	1,14	1,34	1,39	1,22	1,24	1,44	0,31	0,21	0,15

Comparison on the basis of the measurable features of epidermis

The number of stomata (cf. Table 1) is partly of ecologic significance and partly it can be used to separate the species (Shenikov, 1953; Mrs. Simon—Molnáros, 1964; Maróti, 1965). In case of the species examined, its value for an area of 1 sq.mm has changed between 48 and 738.

Inside the family the differences between the single species are considerably smaller. There isn't any significant difference — except the family *Betulaceae* — inside the same family between species belonging to different genera, thus e.g., in the family *Moraceae* between the *Maclura aurantiaca* and *Ficus elastica*, in the family *Fagaceae* between *Quercus robur* and *Castanea sativa*. In the family *Betulaceae* the *Betula pendula* and. *B. nana*, the *Corylus avellana* and *C. colurna* are differring from each other on a five percent level, while some species of the two genera *(Betula nana—Corylus avellana* and *Betula pendula—Corylus colurna)* cannot be separated even on a five percent significance level. On the other hand, in the family *Salicaceae*, even inside the genera *Salix* and *Populus*, the species examined are differring essentially concerning their numbers of stomata (on a level of 1 and 0,1 percent).

Length of guard cells (cf. Table 1).

In case of species examined, it is changing between 13,8 μ and 40,5 μ. In the family *Juglandaceae* the length of guard cells of the species representing all the three examined genera, in the families *Ulmaceae* and *Fagaceae* those representing one genus *(Ulmus)* or more ones *(Fagus, Quercus)*, is not different from the others.

In contradistinction to them, between the examined species of *Moraceae, Betulaceae* and *Salicaceae*, in a great majority of cases, there are differences surpassing even the 0,1 percent SD values. At the same time, the lengths of guard cells of *Ulmus glabra, Betula pendula*, and *Juglans regia* are in a complete accordance with each other.

Width of the guard cells (cf. Table 1).

It changes between 12,3 μ and 34,8 μ (the joint width of two guard cells was measured with the pore of stoma between them). Inside the families *Betulaceae, Fagaceae* and *Juglandaceae*, the widths of the guard cells of some species are identical, however, on the basis of the available data, no general regularity can be drawn concerning the species examined.

L/W ratio of the guard cells (Table 1).

The shape of the guard cells may be well characterized by their L/W ratio. The shape of the guard cells of the species examined — except the family *Ulmaceae* — is elliptical. The extreme values of their L/W are: 1, 1 and 1,4.

The data are the most homogeneous inside the family *Betulaceae;* there is not any significant difference between the ratios L/W of guard cells of the single species.

In the family *Ulmaceae*, the guard cells of the species examined, in contrast to the above-mentioned ones, are longshaped (their L/W ratio being between 1,4 and 1,7).

Comparison on the basis of the formal features of epidermis

The upper and lower epidermis are divided into costal and intercostal fields. The radial wall of cells of the costal fields (above the vascular structure of leaves) is — apart from a few exceptions — generally straight, the cells are strongly lengthened in the direction of the course of the leaf vessels. The radial wall of epidermal cells of the intercostal fields is, viewed from above, straight (quadrangular, quinquangular, sexagonal), tortuous or undulatory. The stomata take place dispersed in the intercostal fields, being of acyclic or monocyclic type (the guard cells are surrounded only by epidermal cells, resp. subsidiary cells). The shape of guard cells is elliptic or lengthened (Plate I).

The number of the adjacent cells or subsidiary cells, connected with guard cells, is in the family *Salicaceae* generally four-five, in the other families, as a rule, five-six (Fig. 1).

Moraceae

The stomata of the *Morus alba* and *Maclura aurantiaca* are of acyclic type. The shape of guard cells is, in case of the species examined, elliptic, a difference occuring only concerning the size of cells (cf. Table 1). It is obvious in epidermal cells that the cuticle is striped, generally agreeing with the direction of the longitudinal axis of cells (Plate I. Fig. 1/4).

The stomata of *Ficus elastica* are characteristic of the plants of xerophyte type: the guard cells are to be found immersed on the bottom of small cavities, covered above by a cuticle film provided with orifices of a direction agreeing with the longitudinal axis of the pores of stomata (Plate I. Fig. 2).

Ulmaceae

The shape of guard cells is lengthened (Table 1). The stomata are of acyclic type, but the adjacent cells surrounding the guard cells of *U. glabra* are stained more strongly, thus separated from the other epidermal cells in respect of staining and, a little, of their shape.

The structure of stomata of the *Celtis occidentalis*, the shape of guard cells are corresponding to those of the two *Ulmuses*. It is anyhow very characteristic of the *Celtis occidentalis* that the number of the adjacent cells surrounding the stomata is, apart from a very few exceptions, four (Fig. 1), and it is obvious, too, how strongly wrinkled the thick cuticle is that is covering the lower epidermal cells. In the adjacent cells, the cuticle is triped generally at right angles to the guard cells (Plate II. Fig. 1).

Betulaceae

The stoma type of the plant species examined of the family is monocyclic, the wall of the subsidiary cells is thinner and stained less

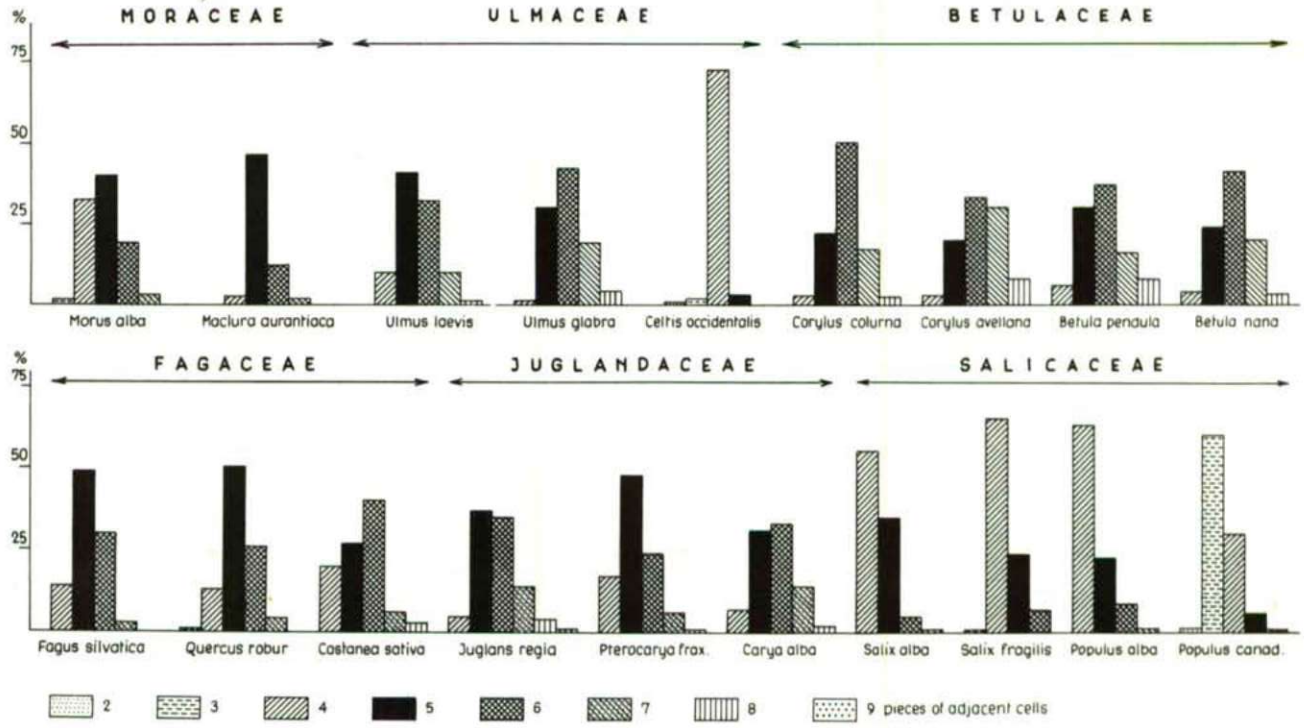

Fig. 1. Percentile distribution of the adjacent cells, resp. subsidiary cells connected with the guard cells in the lower epidermis.

than those of the proper epidermal cells (Plate I. Fig. 1./3). The shape of the guard cells is elliptic (Table 1).

Fagaceae

The morphologic marks of the species examined are highly various, save the shape of guard cells wich is in every case elliptic.

The stomata of *Fagus silvatica* and *Quercus rubra* are monocyclic. The subsidiary cells are stained more strongly; they are different, in shape too, from the other epidermal cells (Plate II. Fig. 2).

The stomata of *Quercs robur, Q. prinus, Q. macranthera* and *Castanea sativa* are of acyclic type.

Juglandaceae

The shape of the guard cells is elliptic (L/W ratio: 1,3; 1,1; 1,3), the stomata are definitely of acyclic type, in genera *Juglans, Carya, Pterocarya,* and *Engelhardtia.* A difference is to be found in the shape of epidermal cells and in the epidermal appendices (Plate I. Fig 1./2).

Salicaceae

The species examined are various in point of morphologic marks. The leaves of the *Salix alba* and *S. fragilis* are amphistomatic, the number of stomata is less in the upper epidermis, and much more in the lower one. The shape of guard cells is elliptic (cf. Table 1). The stoma structure is monocylic, beside the two lateral subsidiary cells there can often be found lateral coronal cells, as well (Plate III. Fig. 1).

The leaves of the *Salix arbuscula* are hypostomatic. The shape of the guard cells is elliptic, their stomata are of monocyclic structure.

The leaves of the *Populus alba* are hypostomatic. The shape of the guard cells is elliptic (cf. Table 1). Their stomata are monocyclic. In the lateral sybsidiary cells the cuticle is striped at right angles to the longitudinal axis of the guard cells.

The stomata of the *Populus tremula* are more differentiated, beside the lateral subsidiary cells also the lateral coronal cells can always be observed. The cuticle is triped much omre (Plate III. Fig. 2./1).

It is characteristic of the species of genus *Populus* that the cuticle covering the cells is strongly striped; on that basis they can well be separated from the species *Salix* and *Populus* inside the *Salicaceae* (Plate III. Fig. 1., 2).

The leaves of the *Populus canadensis* are amphistomatic, their stomata are of monocyclic type, beside the lateral subsidiary cells also a coronal cell can generally be found.

Evaluation of results

1. *On the basis of measurable features*

According to our examinations, a separation of the examined families cannot be solved on the basis of L/W ratio of the guard cells as the difference between the proportional numbers is surpassing the 1 percent level nearly in every family among the species examined. Inside the families, however, there is an opportunity in every case to determine

some species exactly on that basis. E.g., inside the family *Moraceae* the *Maclura aurantiaca*, inside the family *Ulmaceae* the *Ulmus glabra*, from the family *Betulaceae* the *Betula pendula*, from the family *Salicaceae* the *Populus canadensis* could be identified with due certainty. At some species, however, there isn't any difference concerning the L/W ratio of guard cells inside the family, and even between the families. E.g., the L/W ratio of the guard cells of the *Betula nana* and *Fagus sivatica* is completely corresponding (cf. Table 1).

The other features, because of the changes of considerable degree in the function of ecologic factors, can be used, in our opinion, for a sure identification but in extreme cases. E.g., it is probable that inside the family *Moraceae* the *Morus alba* can be separated because of a difference of considerable degree from the two other species even on the basis of the number of stomata (Table 1). Similarly, in the family *Ulmaceae*, the *Celtis occidentalis* can be separated because of the extremely high number of stomata. Concerning the number of stomata, we cannot see any possibility for a further determination among the species examined.

According to our earlier examinations, the influence of environmental factors on length and width of the guard cells is considerable, as well (Pataky, 1967). The families cannot be separated, even concerning these two features, on the basis of our investigations; on the other hand, in extreme cases, inside families, these features, too, can be employed for separating the species. E.g., inside the family *Moraceae*, the stomata of the *Ficus elastica* are nearly three times as large as those of *Morus alba*, and that of the *Maclura aurantiaca* is almost twice as large as that.

Larger taxonomic categories, e.g. families that are close to one another, cannot be separated on the basis of the measurable features examined: we think, however, so that this is generally a smaller problem than a reliable separation of the species inside a family or genus, being considerably helped by a statistic analyses of the measurable features. There are, namely, as a rule, so obvious differences between larger taxonomic categories concerning formal features that their separation is easier and more certain with the methods used in the taxonomy.

2. *On the basis of formal marks*

The results of our examinations are agreeing but partly with the literary statements. The formal marks, used by us, are namely more suitable to characterize greater taxonomic units, maybe families or genera (Plate I. Fig. 1), and are used but rarely for a reliable determination of species.

Thus, inside the family *Moraceae*, in the lower epidermis of the *Ficus elastica* the structure of stomata is the most characteristic, making possible a sure separation of it from the species examined. The stomata described at the *Ficus elastica* are characteristic of the genus *Ficus* (Bargagli, 1901).

The family *Ulmaceae* can be separated, on the basis of the shape of guard cells (L/W ratio: 1,4—1,7), from the other families examined. Inside the family, the *Celtis occidentalis* can be mentioned.

It can be separated inside the family as the thick cuticle layer covering its lower epidermis is characteristically wrinkled (Plate II. Fig. 1); but it cannot be separated from the species *Populus tremula* belonging to the family *Salicaceae* just because of that feature (Plate III. Fig. 2). On the other hand, it is a feature, characterizing exclusively the *Celtis occidentalis,* in the structure of stomata that the adjacent cells surrounding the guard cells are characterized in 73 percent by number four. At the other species, the percentile distribution of the number of adjacent cells is considerably more various.

Inside the family *Betulaceae,* in the (monocyclic) type of stomata, even the genera *(Betula* and *Corylus)* cannot be separated from each other. The shape of subsidiary cells, the thickness of radial walls related to the other epidermal cells, the weaker staining of these cells are characteristic of each of the species examined (Plate I. Fig. 1./3).

The most species and specimens have been examined inside the family *Fagaceae,* thus our results concerning this family are of more general validity. The type of stomata in the developed epidermis is acyclic at some *Quercus* and *Castanea* species, the stomata of *Fagus silvatica* and *Q. rubra* are, however, definitely of monocyclic type (Plate I. Fig. 1./1, Plate II. Fig. 2). The type of stomata is, therefore, in itself not suitable for separating the species from one another; anyhow, it may possibly be used to separate genera and families.

The species examined from the family *Juglandaceae* also cannot be separated from one another on the basis of the formal marks of stomata.

Inside the family *Salicaceae,* the two genera can be separated on the basis of the structure of stomata and the cuticles. The shape of the epidermal and subsidiary cells of species *Salix,* viewed from above, is concerned, beside the lateral subsidiary cells also lateral coronal cells are frequently to be found (Plate III. Fig. 1). On that basis they can be separated from every species examined.

In the lateral subsidiary cells of *Populus* species it is highly characteristic that the thick cuticle is strongly striped, generally at right angles to the longitudinal axis of pores (Plate III. Fig. 2). The striped cuticle, joint with other features of the epidermis, is possibly suitable for determining some species, in conformity with Hluchovsky-Srb's results (1959).

Summary

On the basis of our examinations it may be ascertained:

a) From the measurable features of the leaf epidermis mainly the L/W ratio of guard cells and the stoma count can be used for diagnostic purposes. These features change the least under ecologic influences (Pataky, 1967).

b) A feature alone is rarely enough for a reliable identification; it is generally necessary to have an analysis on the basis of more measurable features.

c) Several formal features together are suitable to define larger taxonomic categories (ordos, families, possibly genera).

d) For determing the species, a joint application of formal and measurable features seems to be the most suitable.

e) At comparison and separation of taxonomic categories it is practical to perform the examinations in the lower epidermis. In the upper epidermis namely, as experienced in each of our cases, there may occur greater differences in function of the environmental factors than in the lower epidermis (Pataky, 1967).

f) An analysis of the measurable features with a mathematic-statistical method is more exact, making possible to demonstrate smaller differences between the single species.

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Plate I

Fig. 1. Lower epidermis with stomata dispersed in the intercostal fields *(Quercus rubra)*, M. x100; 2. epidermal cells of straight walls, stomata of acyclic type *(Engelhardtia Leschén)*, M. x800; 3. elliptic guard-cell shape surrounded by subsidiary cells, a) stoma of monoyclic type *(Betula)*, M. x800; costal and intercostal epidermal cells with the characteristic wrinkles of cuticles *(Maclura aurantiaca)*, M: x300.

Fig 2. *Ficus elastica.* Lower epidermis. M: x800.

Plate II

Fig. 1. *Celtis occidentalis:* lower epidermis, M: x1350.
Fig. 2. *Fagus silvatica:* lower epidermis. M: x800.
Fig. 3. *Juglans regia:* lower epidermis. M: x800.

Plate III

Fig. 1. 1. *Salix alba,* and 2. *Salix arbuscula:* lower epidermis. M: x300.

Fig. 2. 1. *Populus termula:* lower epidermis. M: x500. 2. *Populus balsamifera:* lower epidermis. M: x 800.

PLATE I

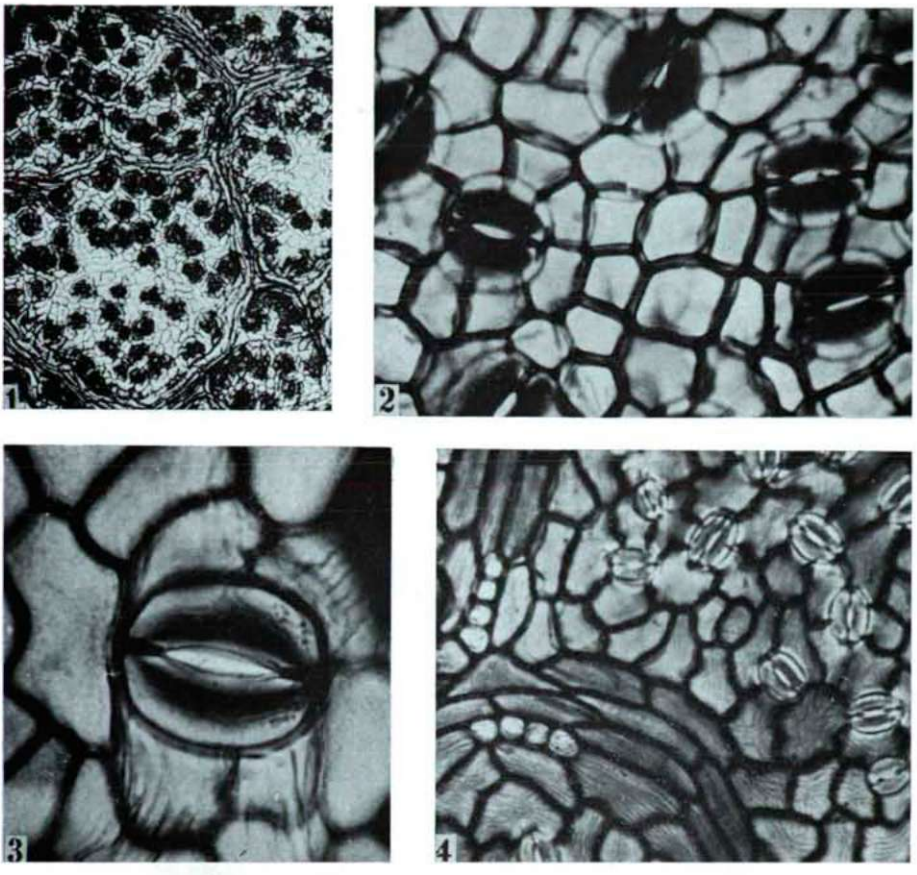


Fig. 1

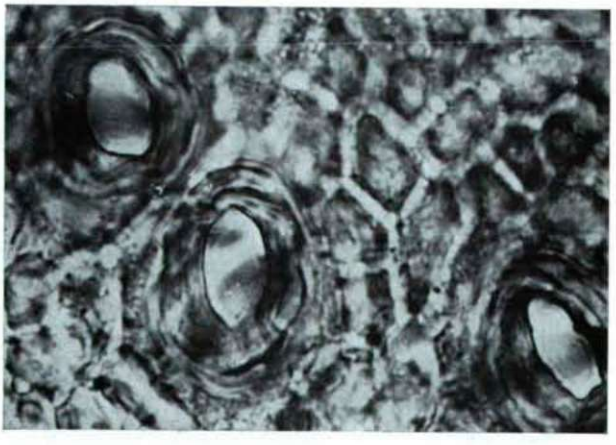


Fig. 2

PLATE II

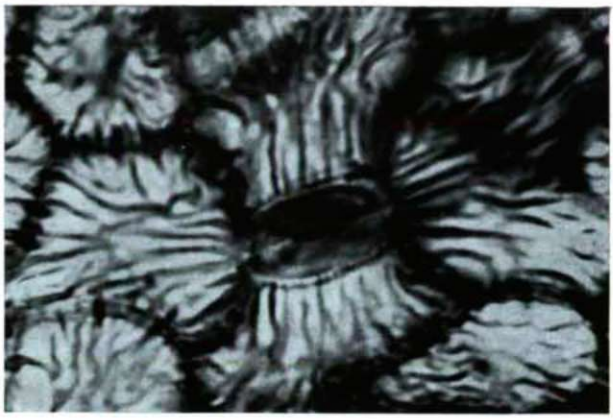


Fig. 1

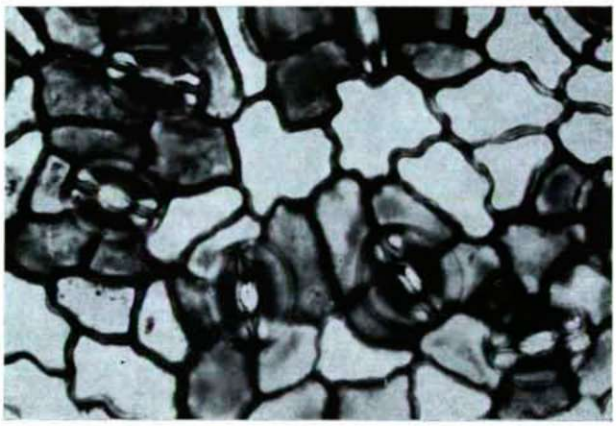
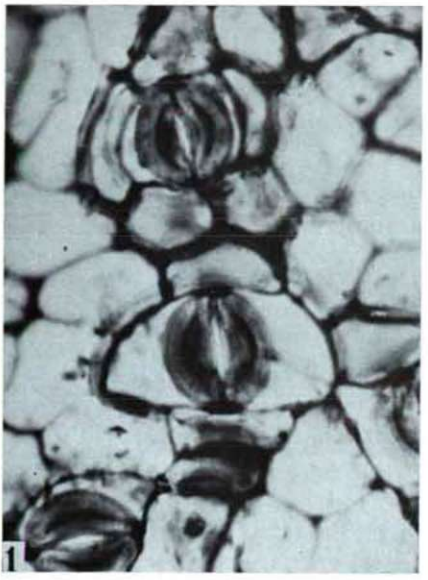


Fig. 2

Fig. 3

PLATE III



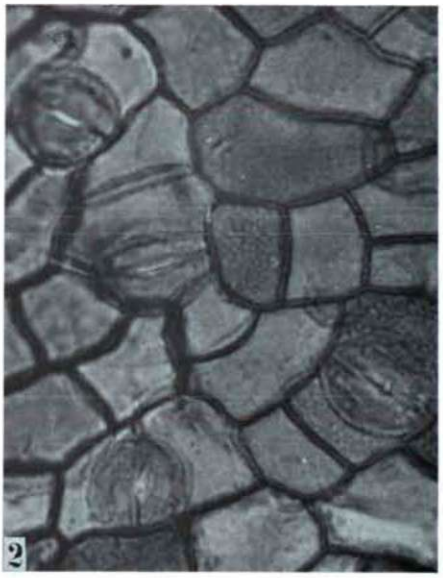


Fig. 1

Fig. 2

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STUDIES ON THE LIGHT SENSITIVITY OF PLANTAGO MAJOR L. SEEDS
I. THE EFFECT OF GIBBERELLIN, KINETIN AND POTASSIUM NITRATE

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Introduction

Plantago major L. seeds have been proved to be light-sensitive in such a way that they do not germinate practically in darkness (Tadros and Rezk, 1966). Stearns (1966) has also examined *P. major* seeds and has found that they germinated only at the rate of 4 % and 0 % in complete darkness at 60° F in two successive seasons.

Thus, it was thought convenient to study this phenomenon in some more details in order to elucidate the response of these seeds to the different agents. In this paper the effect of the most famous dormancy-breaking chemical substances will be experimented. These substances are gibberellic acid (GA_3), kinetin and potassium nitrate.

It is now a well accepted idea that the gibberellins especially gibberellic acid (GA_3) have a pronounced effect on the promotion of germination of dormant seeds, elongation of certain hypocotyls and stem segments. Thus Lockhart (1958) worked on the responses of higher plants to gibberellic acid and light and arrived to the conclusion that gibberellin reverses the light inhibition of etiolated stem growth in certain species. Alcorn and Kurtz Jr. (1958) found that the germination of Carnegiea gigantea seeds was promoted by red light and gibberellin (500—1000 p.pm.). Kahn (1960) working on the effect of gibberellin on lettuce seed germination reported also a similar favourable effect which was further reported by Lona for wild lettuce *(Lactuca scariola)* seeds having its dark germination promoted by gibberellin (citation from Kahn, 1960). This was confirmed by Ikuma and Thimann (1960).

In an article on the „Applied Aspects of the Gibberellins", Stuart and Cathey (1961) stated that the application of the gibberellin to dormant seeds promoted germination in an otherwise unfavourable en-

vironment. The also stated that the germination of light-requiring seeds of lettuce, *Parthenium argentatum* and *Lepidium virginicum* occurred in total darkness with an optimum concentration of gibberellin and that *Lepidium* seeds required a higher and very restricted range of gibberellin concentration for the promotion of germination. In another article on the „Dormancy in Higher Plants" Vegis (1964) described gibberellins as being the substances that may bring about temperature range widening for seed germination and bud break which are able to remove the block that prevents growth activity in wide limits of several conditions. He also stated that in usual cases, gibberellin might substitute for light in the promotion of germination of light-requiring seeds in darkness. Mittal and Mathur (1965) working on the effect of white light and gibberellin on tomato seed germination found that the latter promotes the germination of tomato seeds in dark and light and that the inhibitory effect of light was overcome by GA_3 treatment. Mc Donough (1965) found that both red light and GA_3 treatment increased the germination of *Verbascum thapsus* seeds in proportion to the doses applied. Westra and Loomis (1966) could break the dormancy of *Uniola paniculata* seeds by the application of GA_3 in a concentration of 100 p.p.m. They came to the conclusion that the gibberellic acid treatment accelerated and increased the germination of freshly harvested seeds in a moderate proportion to the concentration of GA_3 applied. Amen (1967) could break the dormancy of the completely dormant *Luzula spicata* seeds by scarifying the hylar end of the seed and applying gibberellin. Anyone treatment of these proved to be useless.

The work on the effect of kinetin (6-furfuryl-aminopurine) is rather more recent. Miller (1956, 1958 and 1961) gives a full report on this compound and its possible role in the promotion of seed germination. He suggested a similarity of the action of both red light and kinetin on lettuce seed germination with the only difference that the kinetin effect was not reversible by far red light. Skinner et al. (1958) stated that not only kinetin is effective in lettuce, carpet grass and clover seed germination but also some other 6-substituted purines have this property. Haber and Luippold (1960) found that lettuce seed germination could be stimulated by gibberellin, kinetin and thiourea, and concluded that kinetin can be considered as a true cell division factor. Khan and Tolbert (1965) found that red light and kinetin were able of reversing the effect of inhibitors of seed germination. Khan (1966) found that kinetin could break the dormancy of the upper seeds of *Xanthium pensylvanicum*. Knypl (1967) showed that kinetin in a concentration of 10^{-4}M is more effective than gibberellin at the same concentration in the reversal of the inhibiting effect of phosphon D (10^{-3} M) on the seeds of *Brassica oleracea* var. *acephala* and that kinetin was about 2.5 times more effective than gibberellin in the reversal of the synergistic inhibition of coumarin (100 p.p.m.) plus phosphon D on the germination of the same seed.

Potassium nitrate solution was also applied by some authors for the break of the light-sensitivity of some seeds (Toole et al. 1955; Alcorn et al. 1959).

Thus, the three substances were tested for their effect on the germination in darkness of *Plantago major* L. seeds.

Materials and Methods

In all the following treatments, seeds of *Plantago major* L. were provided from the University botanic garden in Szeged, a crop of 1967.

Gibberellic acid (GA_3, Phylaxia brand, Budapest) was used in this test. A series of concentrations expressed in p.p.m. was prepared beginning with a stock solution from which lower concentrations were prepared by appropriate dilutions. The concentrations were: 1000, 900, 800, 700, 600, 500, 200, 100, 50, 20 and 10 p.p.m.

Germination was carried out in 9.0 cm Petri-dishes in each of which were fitted two thicknesses of filter paper wetted with 6 ml of distilled water for the test solution. Fifty seeds were sown on each filter paper. Each treatment consisted of four replicates thus using 200 seeds, and the whole experiment was repeated twice. The Petri-dishes were kept in light-proof containers placed in an incubator the temperature of which was maintained at 25± 1°C for 10 hours and at 20± 1°C for 14 hours. The incubator contained fluorescent lamps delivering white light of 2000 lux for 10 hours daily serving as a light source for the control experiment. Two control sets with distilled water as imbibition medium were run simultaneously with the original experiment. The one was put in the light-proof container and the other was outside it, thus receiving 10 hours of white light per day.

After 15 days the germinated seeds were counted and their percentages thus calculated.

The above procedure was followed for testing the effect of kinetin on the germination in the dark of Plantago major seeds. Kinetin was „Sigma brand U.S.A.". Five concentrations were prepared in p.p.m. also for the sake of comparison. The concentrations were 100, 50, 20, 10 and 1 p.p.m. The experiment was run in the same number of replicates and controls as described before for the gibberellic acid experiment.

Working with potassium nitrate only one concentration (0,2 % solution) was prepared as recommended by Toole et al. (1955).

Results and Discussion

The effect of gibberellic acid treatment is graphically expressed in Fig. 1. Each of the points is the mean of eight replicates. It is clear from the figure that there is an increase in the dark germination of *P. major* seeds with the increase of gibberellic acid concentration to a maximum of 96 % attained at the concentration of 800 p.p.m. The changes at higher concentrations are negligible. It was noticed that although the highest concentrations of gibberellic acid gave the highest germination percentages yet they resulted in a restricted growth of the emerged radicles in such a sense that the seedlings produced at lower concentrations were larger in size. The control values were 4 % and 87 % germination in dark and light respectively.

The response of *Plantago major* seeds to gibberellic acid treatment resembles that previously achieved by *Lactuca sativa* seeds var. „Grand Rapids" which were the field of many research works because of their

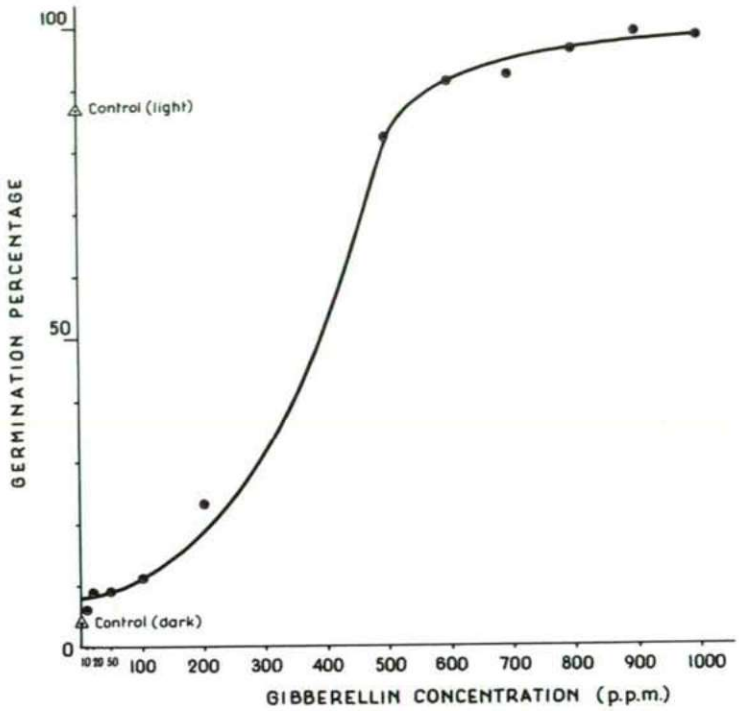

Fig. 1. Effect of gibberellic acid concentrations on the germination of *Plantago major* seeds in the dark.

light sensitivity. The results iven here coincide with those arrived at by many other authors. Thus Kahn (1960), Lona (1956) and Ikuma and Thimann (1960) emphasised the promoting effect of gibberellic acid on the germination of seeds of different species of *Lactuca*. The latter authors mentioned that a maximum germination was attained in the dark by imbibing the seeds of *L. sativa* in 100 p.p.m. gibberellic acid. But the seeds of *Plantago major* required a higher concentration of gibberellic acid and in this respect resemble those of *Saguaro cactus (Carnegiea gigantea)* as mentioned by Alcorn and Kurtz Jr. (1959). These latter seeds needed a concentration of gibberellic acid of 500—1000 p.p.m. to show a rise in the germination percentage.

The same promoting effect of gibberellic acid has been reported for seeds of *Verbascum thapsus* L. by Mc Donogh (1965), for tomato by Mittal and Mathur (1965), and for *Uniola paniculata* by Westra and Loomis (1966). The seeds of the latter species needed only 100 p.p.m. of gibberellic acid for the promotion of their germination, a concentration that raised the germination percentage of *P. major* seeds in the dark from 4 % to 11 % only. But with *Luzula spicata* seeds gibberellic acid failed to promote germination unless a hylar scarification was carried out (Amen, 1967).

Thus gibberellic acid has promoted the germination of *Plantago major* seeds in darkness which normally does not occur. In this respect it coincides with the statement of Stuart and Cathey (1961) in

that it promotes germination in an otherwise unfavourable environment. According to these authors *Lepidium virginicum* seeds needed a hight concentration of gibberellic acid and thus resembling those of *Plantago major* seeds in darkness which normally does not occur. In this respect requirement of these seeds thus confirming the statement of Vegis (1964) in this respect.

Table I. The effect of different concentrations of kinetin solutions on the germination of *Plantago major* seeds in the dark.

Concentrations of kinetin solutions (p.p.m.)	Germination Percentages
100	1,50
50	0,50
20	0,50
10	1,50
1	1,50
Dark control	4,00
Light control	86,75

The experiment with kinetin gave different results. These are shown in Table I. It can be observed that kinetin did not promote the dark germination of *P. major* seeds and even has expressed an inhibitory effect in such a way that the percentages of germination were lower than that of the dark control imbided in distilled water. In this respect these results differ from those given by other authors working on the effect of kinetin on the dark germination of many seeds like Miller (1956, 1958, 1961), Skinner et al. (1958), Haber and Luippold (1960), Khan and Tolbert (1965) and Khan (1966). Anyhow kinetin is not always a promoting agent for different plant tissues. It has been reported to have an inhibitory effect on the elongation of stem sections (De Ropp, 1956). This is in concordance with our results arrived at here with *Plantago major* seeds.

Potassium nitrate solution (0,2 %) gave no effect at all. This result does not coincide with those previously reported for *Carnegia gigantea* seeds by Alcorn and Kurtz Jr. (1959) who could break the light sensitivity of those seeds by imbibing in solutions of 0,05—0,4 % KNO_3. Also Toole et al. (1955) mentioned that the use of KNO_3 solution alone could promote the germination of seeds of *Lepidium* species.

From the foregoing discussion it can be concluded that *Plantago major* seeds have their own needs of germination promotion. While their germinaton is largely promoted in the dark by high concentrations of gibberellic acid, we find that kinetin and potassium nitrate solutions had no promoting effect at all and the former had even an inhibiting effect.

Abstract

Plantago major L. seeds do not germinate normally in complete darkness. Three different chemical germination promoting agents were used in order to fulfill this light requirement.

Gibberellic acid (GA_3) gave a promoting effect that increased with increase of concentration.

Kinetin did not promote the germination of these seeds and even an inhibiting effect was observed.

Acknowledgement

This research was carried out during a fellowship from the Hungarian goverment for which the author is very grateful. The author is also greatly indebted to Prof. Dr. I. Horváth head of the Botanical Institute of the Attila József University Szeged for his interest in this work and his continual criticism and valuable help.

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STUDIES ON THE LIGHT SENSITIVITY OF PLANTAGO MAJOR L. SEEDS
II. THE EFFECT OF RED LIGHT ALONE AND MEDIATED BY CHEMICALS

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Introduction

In an earlier contribution (Rezk, 1968), the effect of gibberellin, kinetin, and potassium nirate solutions on the germination in the dark of the light — sensitive seeds of Plantago major has been investigated. It has been shown in that part of the work that gibberellic acid only could promote the dark germination of those seeds, while the other two chemical substances could not. It is yet always convenient to think of promoting the germination of such light — sensitive seeds by exposing them to irradiation from red light sources for varying periods of time. This promoting effect of red light is reported to be reversible by a subsequent irradiation with far-red light (Bortwick, et al., 1954; Downs, 1955; Alcorn, et al., 1959; Kahn, 1960; Ikuma, et al., 1960; Mohr, et al., 1963; and Mc Donough, 1965...).

A combination of either kinetin or potassium nitrate solutions with red light was thought to promote the germination in the dark of those seeds. Such combinations were previously tried by many other authors. Thus, Toole et al. (1955) could promote the germination of different light-sensitive seeds (e.g. *Lepilium densiflorum)* using 0.2 % KNO_3 solution only after irradiating them with red light. Khan and Tolbert (1965) came to the conclusion that neither kinetin nor red light alone were able to reverse the inhibitory effect of coumarin and xanthatin on seed germination, but only a combination of both treatments was able to reverse this inhibitory effect.

Thus the effect of red light alone and in combination with either kinetin or potassium nitrate solutions on the dark germination of *Plantago major* seeds was experimented here.

Materials and Methods

Irradiation with red light.

Red light was provided from an iodine lamp (Tungsram, 1000 Watt), the light of which was passed through a glass basin containing water to avoid heating of the plant material and then through a metal interference filter (Carl Zeiss, Jena) of 650 mμ. The intensity of the delivered red light was measured by the technique of Horváth and Szász (1965), and was found to be 3400 erg/cm²/sec.

Fifty seeds were sown in each 9 cm. Petri-dish on two thicknesses of filter paper wetted with 6 ml. of distilled water. The seeds were imbibed in the dark for 24 hours before exposure to red light. Irradiation with red light was carried out for any of the following periods: 2, 5, 10, 20, 30, 40, 50, or 60 minutes. There were 200 seeds distributed in four Petri-dishes exposed to red light for each of these time intervals. Attention was paid that the temperature at the seed level did not change during irradiation. After irradiaton for the desired time period, the seeds were returned back to the dark inside an incubator in which the temperature was controlled at 25±1 C° C for 10 hours by day and at 20± 1° C for 14 hours by night daily. A control of unirradiated seeds was simultaneously run. After 15 days of dark incubation of the seeds were examined for the germination percentages. The experiment was repeated twice thus having eight dishes irradiated for each of the mentioned time intervals. For the sake of comparison, red light from fluorescent lamps of the intensity of 10,000 erg/cm²/sec was used in irradiating 200 seeds for one hour after having been imbibed in distelled water for 24 hours.

For the study of the effect of kinetin and potassium nitrate solutions mediated with red light, the seeds were imbibed in the test solution for 24 hours before being exposed to red light as described above.

Five concentrations of kinetin solutions were prepared (1, 10, 20, 50, and 100 p.p.m.) in distilled water.

Potassium nitrate solution used was a 0.2 % solution of the analytical reagent.

For each treatment four hundred seeds were sown in the manner described before. The seeds were first imbibed in the test solution for 24 hours in the dark and then exposed to red light from either sources for one hour. After irradiation, the dishes were returned back to the dark incubator under the same conditions previously described.

Results and Discussion

From table I it is clear that neither red light from the interference filter nor from the flurescent lamps had any stimulatory effect on the germination in the dark of *Plantago major* seeds irrespective of the period of exposure.

The response of the seeds to irradiation with red light from either sources is in contrast to that arrived at by many other authors working on many light-sensitive seeds. For example, Alcorn et al., (1956) could stimulate the dark germination of the light sensitive *Carnegiea gigantea* seeds by irradiating them with red light for 30 minutes. Toole et al. (1955) gave a list of some light-sensitive seeds the dark germination of which was promoted by red light. Lettuce seeds *(Lactuca sativa* var. *Grand Rapids)* and several other varieties were the field of many researches due to their light-sensitivity and due to that they responded by germanition in the dark if they were irradiated with red light. The germination promotion was found to increase with the

Table I. Effect of exposing the seeds of *Plantago major* to red light from two different sources for varying time periods, on their germination in the dark.

Time of exposure to red light (min.)	Germination Percentage
2	3.0
5	2.5
10	2.0
20	3.0
30	3.5
40	3.5
50	3.5
60	4.5
Red light from fluorescent lamps for one hour	4.0
Dark Control	4.0

increase of the exposure period to red light (Borthwick et al., 1954; Kahn, 1960; Ikuma and Thimann, 1960).

More important in this respect is the reported similarity of the action of kinetin and red light as viewed by Miller (1956 and 1958). The only difference in Miller's results was that far-red light reversed only partially the effect of kinetin while it completely reversed that of red light. Powell and Griffith (1960) have reported a similarity in the action of red light and kinetin as both increased the

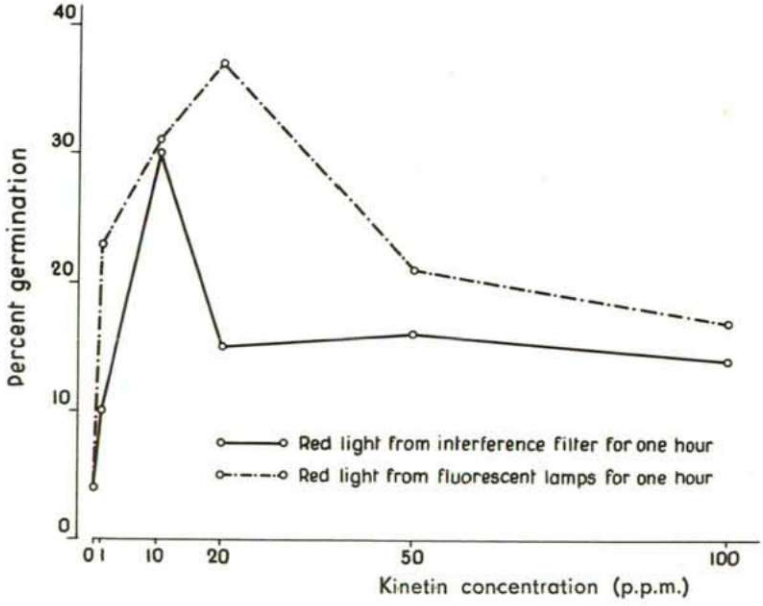

Fig. 1. Effect of kinetin concentrations mediated with two different types of red light on the germination in the dark of the seeds of *Plantago major.*

expansion of discs from bean leaves and both caused greater elongation in stems and petioles of bean seedlings. They added that the action of red light and kinetin together caused a greater increase in size of discs, but kinetin has never physiologically replaced red light.

In our results here there is a parallel similarity in action between red light and kinetin. Both of these two factors failed to promote the dark germination of the seeds of *Plantago major*.

The combination of red light and kinetin gave results that are graphically represented in Fig. 1. It is clear from that figure that kinetin solutions mediated with red light from either sources could promote the germination of *P. major* seeds, but the promotions were higher on using red light from the fluorescent lamps. This difference in response to the different qualities of red light may be attibutable to the higher intensity of red light received from fluorescent lamps. Similar germination promotions by the use of the combination of red light and kinetin have been arrived at by different authors. An example of the synergistic effect of the red light and kinetin was given by K h a n and T o l b e r t (1965) who stated that the inhibitory effect of some naturally-occurring seed germination inhibitors (coumarin and xanthatin) could be reversed only by a combination of red light and kinetin but not by either of them alone.

With potassium nitrate the position was nearly the same as was with kinetin, a germination promotion was obtained when this salt at a concentration of 0.2 % was applied to the seeds in combination with red light from either sources. Table II shows the results of this experiment. It is again shown that the promotion was higher when red light was supplied from fluorescent lamps that it was when the source of red light was the iodine lamp with its interference filter.

Table II. The effect of KNO_3 solution alone and mediated with red light from two different sources on the germination of *Plantago major* seeds in the dark.

Seeds imbibed in 0.2% KNO_3 for 24 hours, and then ...	Germination Percentage
Red light from interference filter for one hour	29.30
Red light from fluorescent lamps for one hour	40.75
Dark Control	3.00

The results obtained with the germination of *Carnegica gigantea* seeds by A l c o r n et al. (1956) coincide greatly with our findings with *Plantago major* seeds here since those light-sensitive seeds were greatly promoted in germination only when subjected to a combined treatment with potassium nitrate solution and red light. T o o l e et al. (1955) also mentioned that *Lepidium densiflorum* and other light-sensitive seeds could only be promoted to germinate in the dark if they were supplied with potassium nitrate solution and irradiated with red light and they mentioned that germination was never initiated if the seeds were imbibed in potassium nitrate solution alone.

Summary

Red light from interference filter or from fluorescent lamps could not promote the germination of the light-sensitive seeds of Plantago major. A combination of red light with either kinetin or potassium nitrate solutions could promote the germination of those seeds in the dark. Irradiation with red light from fluorescent lamps in combination with either of these two chemical substances gave higher germination percentages than when red light from the interference filter was used.

Acknowledgment

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ÜBER DEN URSPRUNG UND DIE VERWANDSCHAFT DER NÓGRÁDER BRAUNKOHLENFLORA IM HELVET

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Bei der Untersuchung der verwandschaftlichen Beziehungen einer fossilen Flora ist die primäre Frage, von welchen älteren Floren die Floraelemente abstammten, welche alten und neuen Typen in gegebener Zeit und Ort vorhanden waren und ob die letzteren Typen sich durch Artentwicklung oder Einwanderung in Komponenten der betreffenden Flora umwandelten.

Eine andere Aufgabe bei der Verwandschaftsforschung ist die zeitlich und räumlich ähnliche Flora, die der fossilen am besten entspricht, unabhängig vom Ursprung zu suchen. Diese Aufgabe führt einerseits zu den biostratigraphischen Problemen, anderseits richtet sie sich auf die Bestimmung der regionalen Floraverwandschaft bei den jüngeren Sedimenten.

Das Ziel der vorliegenden Arbeit ist den Ursprung der Nógráder Braunkohlenflora im Helvet zu suchen, und die regionale Floraverwandschaft zu bestimmen. Dazu sind als Grund die Gattungen und Familien genommen, die durch palynologische Untersuchungen erzielt wurden.

Die vorliegende Arbeit befasst sich nicht mit den stratigraphischen Fragen, weil die durch palynologische Untersuchungen erhaltenen Taxa auch im Neogen wenig Grund, die Sporen- und Pollenformen jedoch einen genügenden Grund zur Sporenstratigraphie geben. Vom Autor wird die Sporenstratigraphie nicht als botanisches, aber angewandtes-geologisches Problem betrachtet.

Die zeitliche Floraverwandschaft

Untersucht man die terrtiären Floren in der Folge des Zeitalters, so soll man die Krischtofovitsch's (1959) Konzeption in Betracht ziehen. Danach dehnte sich in userem Raum im Unterpaläogen das Gelindener, nördlich jedoch das Grönlander Floragebiet aus. Die Flora von Gelinden (Belgium) hat einen tropischen, heissen und humiden Charakter. Da sich dieses Floragebiet im Tethys-Becken und dessen

Inseln und Küsten ausdehnte, wurde seine Flora von Szafer (1961) mit allgemeinerem Namen Tethys-Flora benannt. Für sie sind die Palmengattung *Nypa*, die Familien *Araliaceae, Lauraceae, Myrtaceae, Sterculiaceae* und andere wärmeliebende und humide Elemente charakteristisch.

Die Tethys-Flora wurde von der Krischtofovitsch-schen Poltavaer Flora umgewechselt, die noch immer heiss aber zeitweise trockener war. Von Szafer (1961) wurde diese Flora Paratethys-Flora genannt, weil nach ihm „this name would clearly indicate the disintegration of the Tethys into a number of derivate (para-Tethys) seas and refer to the orogenic movements that were closely connected with the transgressions and regressions of those seas in Europe".

Parallel mit dieser Flora, östlich vom Ural lebte die Turgaier Flora nach Krischtofovitsch. In dieser Flora wurden Wälder durch die laubwerfenden, gemässigten Elemente, als *Fagus, Castanea, Zelkova, Cercidiphyllum, Magnolia, Quercus, Tilia, Liriodendron, Acer, Phellodendron, Liquidambar, Vitis, Actinidia* und andere gebildet. Aber die Turgaier Flora besteht nicht nur aus ostasiatischen, sondern auch aus nordamerikanischen Elementen. Deshalb hielt Szafer (1961) den Namen, der nur die Einwanderung der Ostasiatischen Wälder über das Turgaier Tor ausdrückt, zu eng. Nach ihm „this zone was, generally speaking, Holarctic or circumpolar i.e. its wide belt comprised the whole of Europe and North America".

In unserem Fall stellen wir die Frage, ob sich die drei Floren (Tethys, Paratethys, holarktische Flora) in Nógrád an Hand der Palynologie nachweisen lassen, in welchem Masse der tropische Charakter der Nógráder Braunkohlenflora übrig blieb und wie gross der Grad der Vermengung zwischen den subtropischen (Poltavaer) und den laubwerfenden (holarktischen) Waldelementen war.

Die sichere Stellungnahme wird durch die Unsicherheit und die geringe Tiefe der Bestimmungen des Sporen- und Pollenmaterials erschwert.

Unter den Pteridophyten lässt sich keine einzige Gattung aus der Nógráder Braunkohlenflora erwähnen, die sich auf die Tropen beschränkt. Zwar lebt die Gattung Psilotum innerhalb der Grenzen der Tropen in Amerika, aber ihr Areal dehnt sich auch bis in die subtropischen Gebiete in Ostasien und Austrialien hinein. Unter den *Osmunda*-Arten könnte auch die tropische *O. javanica* vorkommen, aber ihre Bestimmung ist unsicher. Auch die Arten der Gattung *Lygodium* sind grösstenteils tropisch, aber einzelne Arten kommen auch in der gemässigten Zone vor. Ob sich ausschliesslich tropische Gattungen bzw. Arten unter den *Polypodiaceen* befinden, ist auf dem heutigen Stand der Bestimmungen noch nicht feststellbar. Die Gattungen *Selaginella, Lycopodium* und *Equisetum* sagen nichts bestimmtes in dieser Beziehung.

Weil die Geschichte und Verbreitung der *Pteridophyten* anders war als bei den *Angiospermatophyten*, kann man hier nicht über Tethys-, Paratethys oder holarktische Florenelemente sprechen.

Unter den *Gymnospermen* befinden sich keine tropischen Elemente. Zwar wurden Pollenkörner der *Cycadopsiden* und *Araucariaceen* be-

stimmt, ihre Bestimmungen sind jedoch ungewiss und die Exinen können auch umgelagert sein. Es ist anzunehmen, dass die Gattung *Ephedra,* als trockeneres und wärmeliebendes Element in der Paratethys-Flora teilnahm. Die anderen Gattungen *Taxodium-Glyptostrobus, Sequoia-Metasequoia-Cryptomeria, Sciadopitys, Pinus, Picea, Abies, Keteleeria, Cedrus, Pseudotsuga-Larix* sind zwar heute holarktisch, aber sie sind im allgemeinen älter als die holarktische Turgaier Flora.

Die tropischen Familien der Nógráder *Angiospermen* sind *Lauraceen, Myrtaceen, Araliaceen, Clethraceen, Sapindaceen, Sapotaceen, Symplocaceen,* die in userem Gebiet aus der Gelindener Flora über die Poltavaer übrigblieben und sich mit weiteren tropischen und subtropischen Elementen, wie *Anacardiaceen* und einzelnen Gattungen der *Juglandaceen, Cyrillaceen, Palmen* vermehrten. Zu diesen gestellten sich die gemässigten, laubwerfenden Elemente, die aus der holarktischen Flora in das Nógráder Gebiet einwanderten, wie *Magnolia, Liquidambar, Tilia, Ulmus-Zelkova, Alnus, Betula, Corylus, Carpinus, Ostrya, Fagus, Castanea, Quercus, Myrica, Salix* und andere.

Werden die quantitative Daten zu den skizzierten hinzugefügt, so erweist sich, dass die tropischen Elemente den subtropischen und gemässigten untergeordnet waren. Die Paratethys- und die holarktischen Elemente lebten in vollkommener Vermengung nebeneinander. In dieser Stufe des Miozäns ist die Verbindung zwischen den Gebieten der Poltavaer und Turgaier Floraprovinzen vollkommen geworden, wo die Poltavaer Elemente in Rückgang, die holarktischen Elemente in Vorstoss waren.

Die regionale Floraverwandschaft

In der europäischen palynologischen Literatur behandelt M a c k o (1957) die regionale Verwandschaft der unteren Miozänflora von Klodnica am ausführlichsten. Der Autor stimmt nicht mit M a c k o's (1957, 1959) Methode überein. Er vergleicht nämlich die miozänen Sporen und Pollenkörner mit den rezenten und bezeichnet die Fossilien nach dem rezenten Pollentyp (z.B. *Morus rubra* L.-type) und arbeitet bei seinen Folgerungen schon mit der rezenten Art weiter. Der Autor hält es für realer, wenn der Palynologe bei seinen Folgerurgen die Gattungen und Familien als Grundlage annimmt, weil die Mehrzahl der miozänen Pflanzenarten nicht mit den rezenten identisch ist. Die Gattungen waren jedoch schon damals ausgebildet und somit können die letzteren eher als Grundlage zur Feststellung der regionalen Floraverwandschaft dienen.

Bei der Nógráder helvetischen Flora dienten als Grund die heutigen Areale von fünfzig Gattungen und vier Familien, die mit Sporen und Pollen vertreten sind. Aufgrund der Areale wurde eine Karte verfertigt (Tafel I), auf der die Taxa mit je einem Stricht auf jenen Erdteilen, wo sie vorkommen, eingezeichnet sind. Wenn eine Gattung z.B. auch in Amerika, Europa und Asien verbreitet ist, wurde ihr Areal auf alle drei Kontinente mit je einem Strich, dessen äussere Grenze durch die nördlichste und südlichste Punkte des Areals gegeben sind, bezeichnet.

Der Autor bemühte sich dem Mangel der horizontalen Ausdehnung der Areale abzuhelfen, indem er die Verbreitung bezeichnende Striche der Taxa annäherungsweise auf das Terrain bezeichnete, wo das Zentrum der Areale ist.

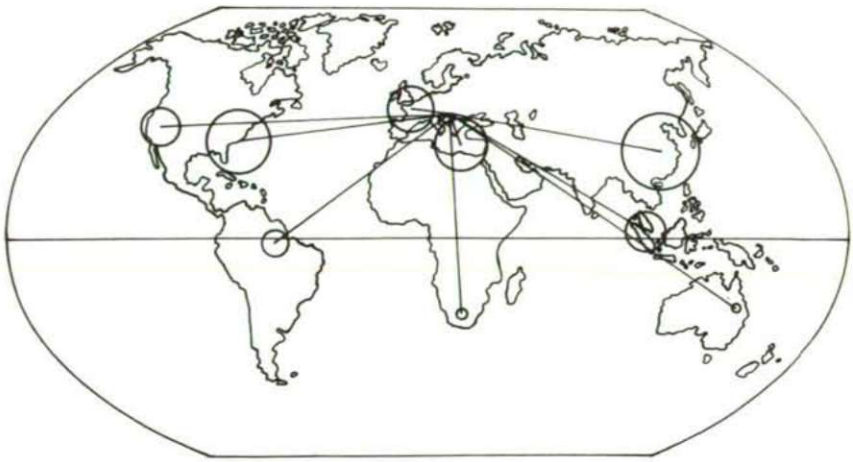

Abb. 1. Regionale Verwandschaft der Nógráder Braunkohlenflora.

Die benützten Taxa haben grosse Areale; es gibt kaum je eine Gattung, deren Areal sich nur auf eine einzige Floraprovinz beschränkt. Die Areale kreuzen sich gegenseitig wesentlich in grösserem Masse, als wenn man mit Arten arbeitet.

Von den Nógráder 50 Gattungen und 4 Familien kommen 26 in der europäischen Holarktis, 27 im Mediterran vor. In der Holarktis von Asien leben heute 45 Taxa, von denen gedeihen 43 auch in Ostasien. In der Holarktis von Amerika befinden sich 39 Gattungen und Familien, von denen 36 auch auf dem atlantischen, 22 auf dem pazifischen Gebiet vorkommen. In den Paläotropen leben 22 Taxa der Nógráder Flora, aber

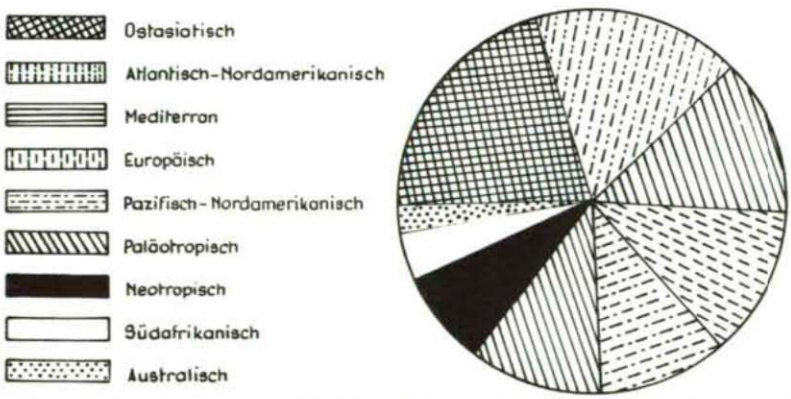

Abb. 2. Die vergleichenden quantitativen Daten der Verwandschaft der Nógráder Braunkohlenflora.

zwischen ihnen zählen nur 6 zu den echten tropischen Gattungen bzw. Familien. In den Neotropen sind 17 Taxa aber nur 4 echte tropische vorzufinden. Von der fossilen Flora gedeihen heute in Südafrika 6, in Australien 5 Gattungen und Familien.

Die obigen Vorkommen sind in einer Karte (Abb. 1), die prozentuelle Werte aber in einem Diagramm (Abb. 2) dargestellt.

Vergleicht man die nicht tief gegliederte Floraverwandschaft mit der helvetischen Makroflora von Magyaregregy, die von Andreánszky (1955 b) untersucht war, lässt sich feststellen, dass Ähnlichkeiten trotz der Verschiedenheiten zwischen der Makro- und Mikrofloren sind. Die Ähnlichkeiten äussern sich durch das Übergewicht der ostasiatischen sowie durch die starken Floraverwandschaft mit atlantischen Nordamerika. In beiden Floren sind die Elemente von Mediterran und Nahen Osten beträchtlich, in der Nógráder Flora jedoch scheint die europäische Verwandschaft stärker, die malaiische jedoch schwächer als in Magyaregregy vertreten zu sein.

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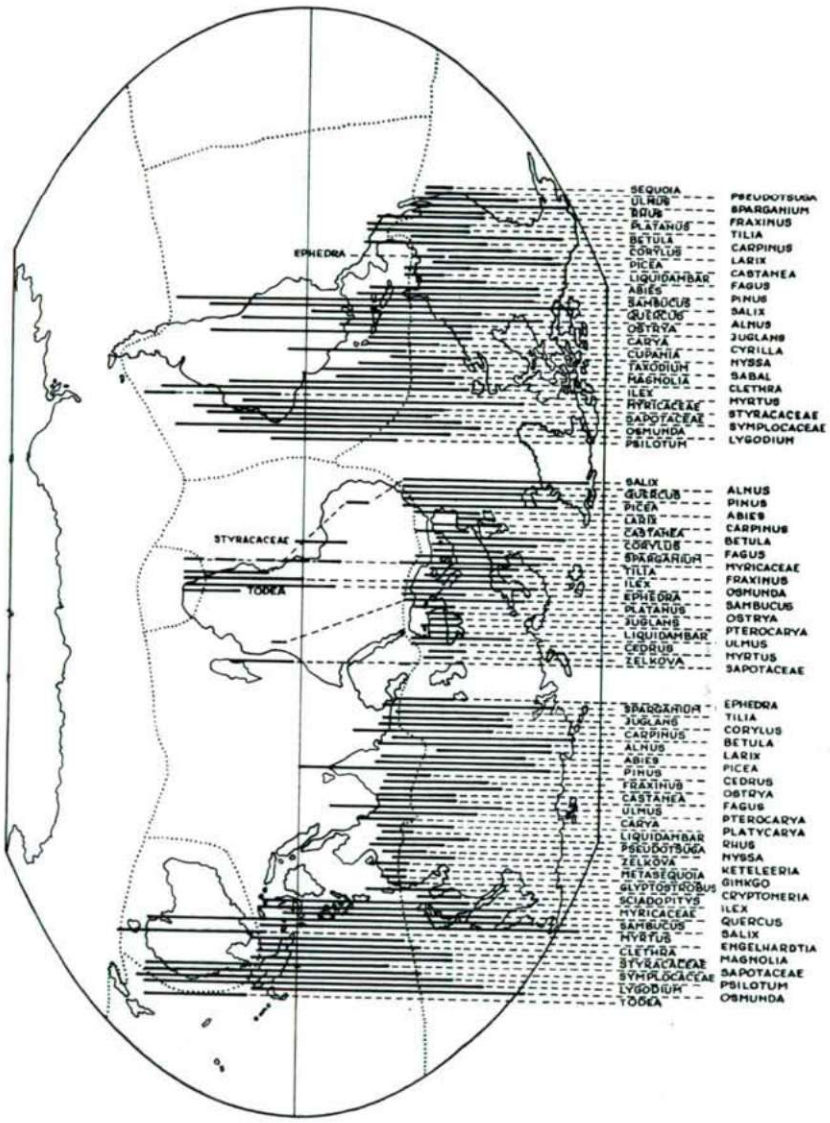
TAFEL I. Die nördlichen und südlichen Grenzen der heutigen Areale der Nógráder miozänen Gattungen und Familien.

TAFEL I


SEQUOIA
ULMUS
BRUS
PLATANUS
BETULA
CORYLUS
PICEA
LIQUIDAMBAR
ABIES
SAMBUCUS
QUERCUS
OSTRYA
CARYA
CUPANIA
TAXODIUM
MAGNOLIA
ILEX
MYRICACEAE
SAPOTACEAE
OSMUNDA
PSILOTUM
PSEUDOTSUGA
SPARGANIUM
FRAXINUS
TILIA
CARPINUS
LARIX
CASTANEA
FAGUS
PINUS
SALIX
ALNUS
JUGLANS
CYRILLA
NYSSA
SABAL
CLETHRA
MYRTUS
STYRACACEAE
SYMPLOCACEAE
LYGODIUM
EPHEDRA
STYRACACEAE
TODEA
SALIX
QUERCUS
PICEA
LARIX
CASTANEA
CORYLUS
SPARGANIUM
TILIA
ILEX
EPHEDRA
PLATANUS
JUGLANS
LIQUIDAMBAR
CEDRUS
ZELKOVA
ALNUS
PINUS
ABIES
CARPINUS
BETULA
FAGUS
MYRICACEAE
FRAXINUS
OSMUNDA
SAMBUCUS
OSTRYA
PTEROCARYA
ULMUS
MYRTUS
SAPOTACEAE
SPARGANIUM
JUGLANS
CARPINUS
ALNUS
ABIES
PINUS
FRAXINUS
CASTANEA
ULMUS
CARYA
LIQUIDAMBAR
PSEUDOTSUGA
ZELKOVA
METASEQUOIA
GLYPTOSTROBUS
SCIADOPITYS
MYRICACEAE
SAMBUCUS
MYRTUS
CLETHRA
STYRACACEAE
SYMPLOCACEAE
LYGODIUM
TODEA
EPHEDRA
TILIA
CORYLUS
BETULA
LARIX
PICEA
CEDRUS
OSTRYA
FAGUS
PTEROCARYA
PLATYCARYA
RHUS
NYSSA
KETELEERIA
GINKGO
CRYPTOMERIA
ILEX
QUERCUS
SALIX
EMGELHARDTIA
MAGNOLIA
SAPOTACEAE
PSILOTUM
OSMUNDA

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ENZYMOLOGICAL INTERPRETATION OF UTILIZATION PATTERNS OF SUGARS USED IN YEAST TAXONOMY

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Introduction

In yeast taxonomy morphological and physiological-biochemical properties are used for characterization of species. As physiological-biochemical properties in the first place assimilation and fermentation of different sugars are taken into consideration (Stelling-Dekker, 1931; Lodder, 1934; Diddens and Lodder, 1942; Lodder and Kreger- van Rij, 1952; Kudriavzev, 1954, 1960; Novák and Zsolt, 1961). According to the general practice assimilation and fermentation of six sugars (diagnostic sugars) are investigated with similar methods. The sugars and the symbols of them used in this paper are the following ones:

glucose: D	sucrose: S	lactose: L
galactose G	maltose: M	raffinose: R

The use of symbols and formulas representing physiological-biochemical properties was several times proposed in yeast taxonomy too (e.g. Rieth, 1958; Rieth and Schönfeld, 1959; Novák, 1960 b; Vörös-Felkai and Novák, 1960, Artagaveytia-Allende, 1961).

The diagnostic experiments show presence or absence of assimilation and fermentation of these sugars and these data are considered as properties of the investigated organisms.

Usefulness of this method is evident. Results obtained on the basis of the monographs of the Dutch School are the best proof of it. But at the same time several problems arose. The experimental results are not unambiguous; the same assimilation (growth in the presence, as sole carbon source, of the sugar investigated) and fermentation (gas production in the presence of the sugar investigated) may have a different enzymatic basis. E.g. $^1/_3$ raffinose may be fermented on two ways: 1. β-h-fructosidase splits off fructose (melibiose remains unfermented) and 2. α-galactosidase splits off galactose (sucrose remains untouched). A manometric test shows in both cases fermentation of $^1/_3$ raffinose. It is obvious that to design identically these two cases would be incorrect. Chromatographic control is necessary to determine the type of raffinose splitting (Novák, 1960 a).

Ability to utilize (by assimilation or/and fermentation) a sugar is very important for the organism. It determines the possibility of occurence in a medium and influences competition with other organisms. Kudriavzev (1954, 1960) called emphatically attention to the correlation between the sugars of the substrates and the sugar utilization ability of yeasts occurring in them. Adaptation to the environment is an important factor in evolution. Kudriavzev's comments, as demonstrations of a general connection on special objects, are both general biologically and yeast taxonomically of high value. Naturally, different ways of adaptation to a given sugar are possible. E.g. sucrose splitting may be performed by a β-h-fructosidase, an α-glucosidase etc.

Yeast taxonomists characterize their strains by the results of the diagnostic experiments. Enzymological evaluation of these experiments is in general lacking although positivity or negativity of the diagnostic experiments are only expressions of the enzymes of the organisms; the enzymes are the material basis for the physiological-biochemical properties.

On the basis of utilization of different sugars one may conclude the presence of some enzymes. E.g. the Embden-Meyerhof-Parnas (EMP) way is probably generally occurring in yeast fermentations. This means that fructose fermentation needs ATP ⟶ hexose transphosphatase, fructose and glucose fermentation needs, apart from this, phosphogluco-isomerase too while fructose, glucose and galactose fermentation needs also the enzymes of the galacto-waldenase complex (ATP ⟶ galactose transphosphatase, phosphogalactose-isomerase and glucose- [1 ⟶ 6] -phosphomutase) to say nothing of the permeases.

In this paper authors try to make such evaluations on the basis of literary and own data. They consider worth trying these theoretical deductions because, due to methodical difficulties, direct demonstration of the different enzymes will be not possible still for a long time, at least in case of several hundred species and many thousand strains.

Biochemical interprepation of the simple sugar utilization spectra

Authors think that the data on utilization of the six diagnostic sugars concerning about 300 species collected in their previous work

TABLE I. Sugar utilization combinations described

	assimilation	fermentation		assimilation	fermentation
D	+	+	$DGSR_3$	(+)*	+
DG	+	+	DGML	+	+
DS	+	+	$DGMR_1$	+	+
DM	+	+	$DGLR_1$	+	—
DGS	+	+	DSM_1R	+	+
DGM	+	+	$DSMR_2$	(+)*	+
DGL	+	+	DGSML	+	—
DGR_1**	+	+	$DGSM_1R$	+	+
DSM	+	+	$DGSMR_2$	(+)*	+
DS_1R**	+	+	$DGSMR_3$	+	+
DGSM	+	+	$DGSL_1R$	+	+
DGSL	+	—	$DGSML_1R$	+	+
DGS_1R	(+)*	+	$DGSMLR_3$	+	—

* Raffinose assimilation was mostly not determined quantitatively and so one can not establish the combination to which the description belongs. In most cases the proportion of utilization could be deduced on the basis of enzymological considerations.

** $_1R$ means raffinose splitting into fructose and melibiose and utilization of fructose; R_1 means raffinose splitting into galactose and sucrose and utilization of galactose; R_2 means a raffinose splitting into glucose, fructose and galactose and utilization of glucose and fructose; R_3 means utilization of the hole raffinose molecule.

(Zsolt and Novák, 1961; Novák and Zsolt, 1961; the nomenclature of these works will be used) may serve a reliable basis for their deductions. The same way will be followed on which authors obtained, by trial and error, their results.

TABLE II. Combinations combinatorically deduced*

D	DSR_1	$DGMR_1$	DGSML
DG	DSR_2	$DGMR_2$	$DGSMR_1$
DS	DSR_3	$DGMR_3$	$DGSMR_2$
DM	DML	$DGLR_1$	$DGSMR_3$
DL	DMR_1	$DGLR_2$	$DGSLR_1$
DR_1	DMR_2	$DGLR_3$	$DGSLR_2$
DR_2	DMR_3	DSML	$DGSLR_3$
DR_3	DLR_1	$DSMR_1$	$DGMLR_1$
DGS	DLR_2	$DSMR_2$	$DGMLR_2$
DGM	DLR_3	$DSMR_3$	$DGMLR_3$
DGL	DGSM	$DSLR_1$	$DSMLR_1$
DGR_1	DGSL	$DSLR_2$	$DSMLR_2$
DGR_2	$DGSR_1$	$DSLR_3$	$DSMLR_3$
DGR_3	$DGSR_2$	$DMLR_1$	$DGSMLR_1$
DSM	$DGSR_3$	$DMLR_2$	$DGSMLR_2$
DSL	DGML	$DMLR_3$	$DGSMLR_3$

* Presupposition was the obligatory presence of glucose in each combination. The possibility that in the case of lacking glucose utilization other sugars may be utilized, here was not taken into consideration because this was not yet observed among yeasts. Between $_1R$ and R_1 was made no distinction.

TABLE III. Combinations not yet observed

DL	DLR_1	$DMLR_1$
DR_1	DLR_2	$DMLR_2$
DR_2	DLR_3	$DMLR_3$
DR_3	$DGSR_2$	$DGSLR_2$
DGR_2 ?*	$DGMR_2$?*	$DGSLR_3$
DGR_3 ?*	$DGMR_3$?*	$DGMLR_1$
DSL	$DGLR_2$	$DGMLR_2$
DSR_2 ?****	$DGLR_3$	$DGMLR_3$
DSR_3 ?**	DSML	$DSMLR_1$
DML	$DSMR_3$	$DSMLR_2$?****
DMR_1	$DSLR_1$	$DSMLR_3$?**
DMR_2	$DSLR_2$	$DGSMLR_2$?***
DMR_3	$DSLR_3$	

?*, ?**, ?***, ?****

The combinations for assimilation and fermentation are here summarized; the lack of combinations designated with mark of interrogation may be deduced only logically.

Combinations marked with * can have R_2 and R_3 only with invertase, but this would involve sucrose utilization too. In combinations marked with ** R_3 would be possible only when galactose utilization is also positive. In combinations marked with *** galactose positivity is incompatible with R_2; it involves R_3! Lack of the combinations marked with **** will be proved later. 1 $_1R$ and R_1 were not distinguished.

The sugar utilization combinations observed and described till now are collected in Table I, in Table II the sugar utilization combinations which may be deduced with the aid of the theories till now are demonstrated.

Comparing the two Tables it emerges that some of the deduced combinations are not yet described; these are collected in Table III.

One may attempt to give an enzymatical explanation for the lack of these combinations. However, simply supposition absence of „agluconspecificity" cannot solve the problem. In this case only combinations collected in Table IV would remain.

Being unable to obtain this way the described combinations, the following suppositions were chosen as start:

a) Disaccharides and raffinose are split only by hydrolysis to monosaccharides and enter this way the metabolism.

b) The presence of the following hydrolytical enzymes is supposed: lactase (β-galactosidase), melibiase (α-galactosidase), maltase (α-glucosidase), and invertase (β-h-fructosidase).

c) Galactose supplied as such or split off from oligosaccharides is transformed into glucose-6-phosphate by the galactowaldenase complex.

d) Lactose splitting occurs only in yeasts able to perform the galactose ⟶ glucose transformation too. In other words: appearance of lactose splitting does not precede glactose ⟶ glucose transformation, at most they appear simultaneously. Rogosa (1948) observed that a yeast strain adapted to lactose became adapted at the same time also to galactose. No description is known in which a yeast utilizing lactose does not utilize galactose too. Pardee (1957) observed induction of β-galactosidase synthesis by lactose and melibiose alike.

e) In case of raffinose the induction of α-galactosidase is similarly connected with the synthesis of the enzymes of the galactose ⟶ glucose

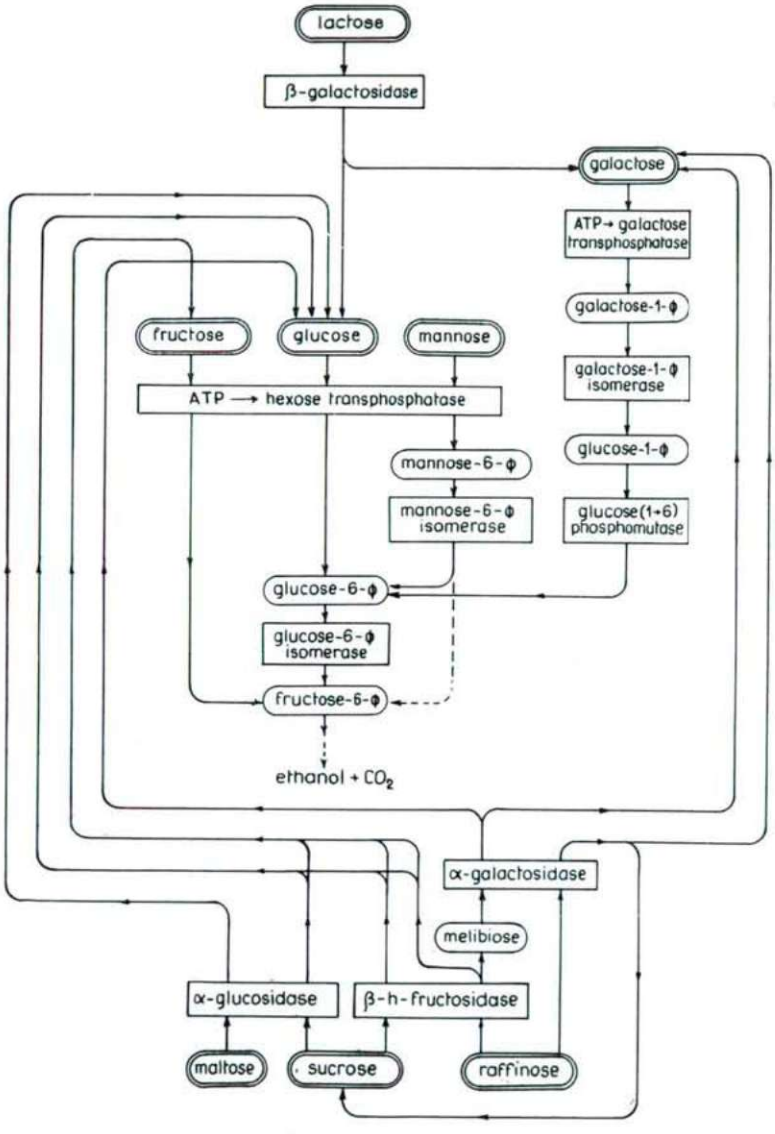
TABLE IV. Combinations remaining when ,,aglucon-aspecific''* glucosidases are supposed

D	$DSLR_1$
DG	$DSLR_2$
DL	DGSML
DGL	$DGSMR_1$
DGR_1	$DGSMR_3$
DSR_1	$DGSLR_1$
DSR_3	$DGSLR_3$
$DGSR_1$	$DSMLR_1$
$DGSR_3$	$DSMLR_2$
$DGLR_1$	$DGSMLR_1$
DSML	$DGSMLR_3$

* „Aglucon aspecificity" relate to α-glucosidase (which splits maltose and sucrose alike) and to β-h-fructosidase (which splits raffinose and sucrose as well). It must be noted thatwhen raffinose is split by melibaise instead of invertase, the combination must contain G because in this case the galactose part of raffinose is utilized (DGR_1, $DGLR_1$). $_1R$ and R_1 are not distinguished.

PLATE I. Metbolic pathways of the diagnostic sugars.

PLATE I


lactose
β-galactosidase
galactose
ATP→ galactose transphosphatase
galactose-1-φ
galactose-1-φ isomerase
glucose-1-φ
glucose(1→6) phosphomutase
fructose
glucose
mannose
ATP → hexose transphosphatase
mannose-6-φ
mannose-6-φ isomerase
glucose-6-φ
glucose-6-φ isomerase
fructose-6-φ
ethanol + CO_2
α-galactosidase
melibiose
α-glucosidase
β-h-fructosidase
maltose
sucrose
raffinose

transformation. No yeasts were described with a $^3/_3$ raffinose fermentation, which do not ferment also the galactose supplied separately.

The processes and enzymes mentioned above are summarized in Plate I.

In authors' first deduction (Figure 1) beginning with the simplest case (utilization of glucose alone) sugar utilization combinations were deduced by adding one by one the enzymes supposed with the restriction that galactosidases must be preceded by the galactowaldenase complex. In this first deduction also raffinose splitting ability of melibiase and invertase was taken into consideration.

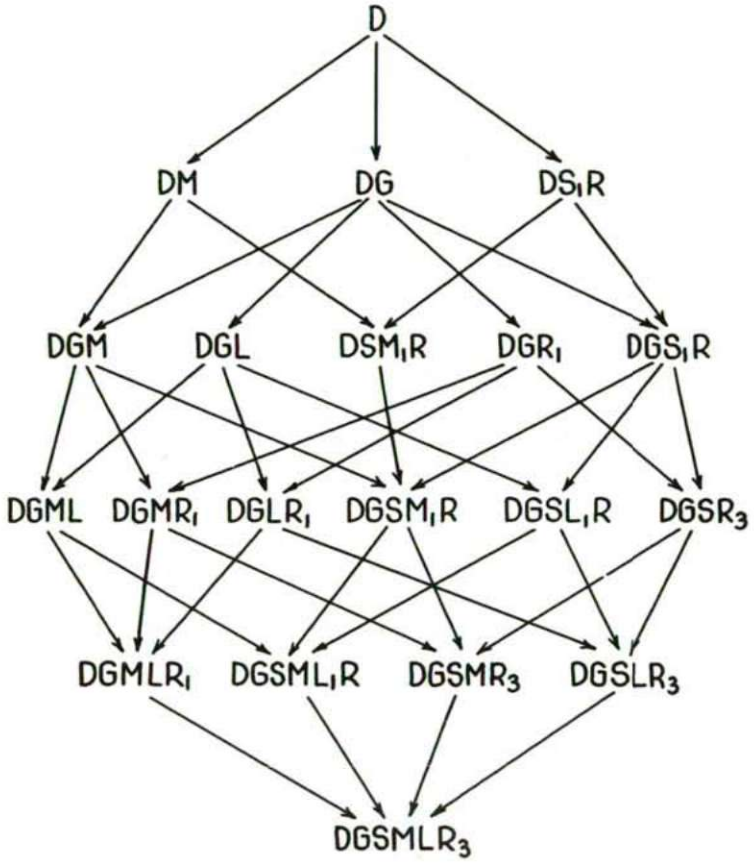


Figure 1. First deduction of the sugar utilization combinatons. Sucrose splitting ability of maltase was here not supposed.

As may be seen, the combinations obtained do not correspond to the combinations observed.

Thereafter it was supposed that maltase (α-glucosidase) is not strictly specific and can split sucrose too. This second deduction is seen in Figure 2, and 2 a.

Although the second deduction produced combinations lacking in the first one, some combinations from the first deduction were missing. After all, nor this deduction gave a satisfactory result. (It is remarkable that some combinations present themselves on an enzyme-level earlier. Due to the sucrose splitting of maltose $^3/_3$ raffinose may be utilized without invertase if splitting begins by melibiase at the galactose end of the molecule.)

Drawing together the two deductions facultativity of sucrose splitting by maltase is supposed. This was suggested by the results of Kosikov et al. (1956) about adaptive sucrose splitting of maltase. Nor this third

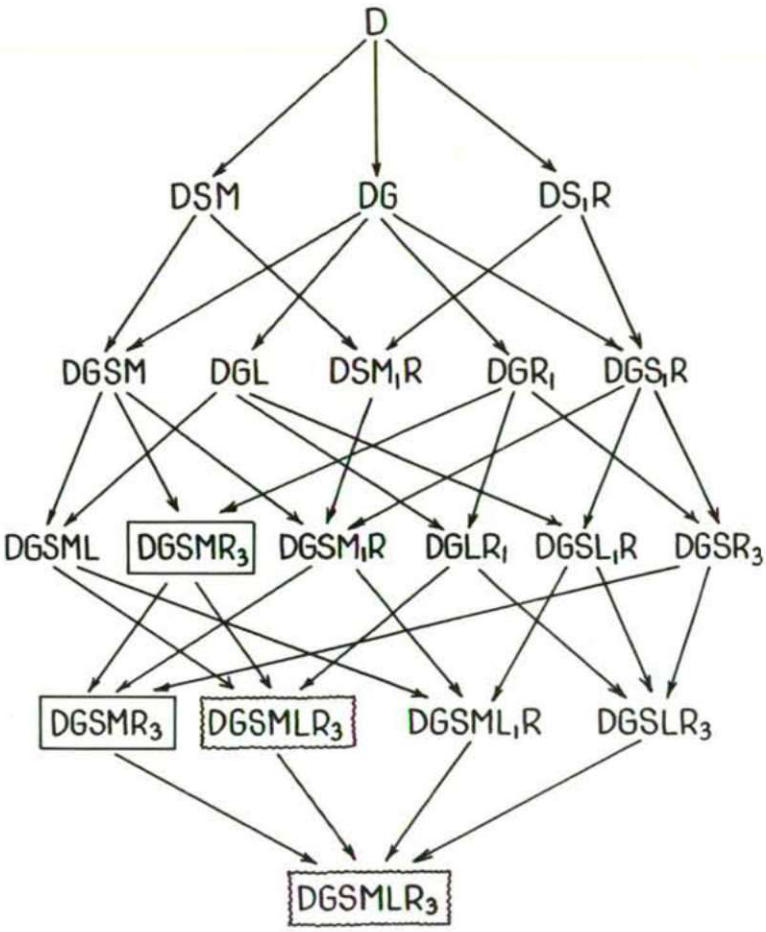


Figure 2. Second deduction of the sugar utilization combinations. Maltase was supposed to split maltose and sucrose alike. Formulas with the same framing emphasize identical utilization; due to sucrose splitting by maltase some combinations appear earlier in the deduction. Adding invertase to these combinations do not change them, only the enzymatical basis will be altered.

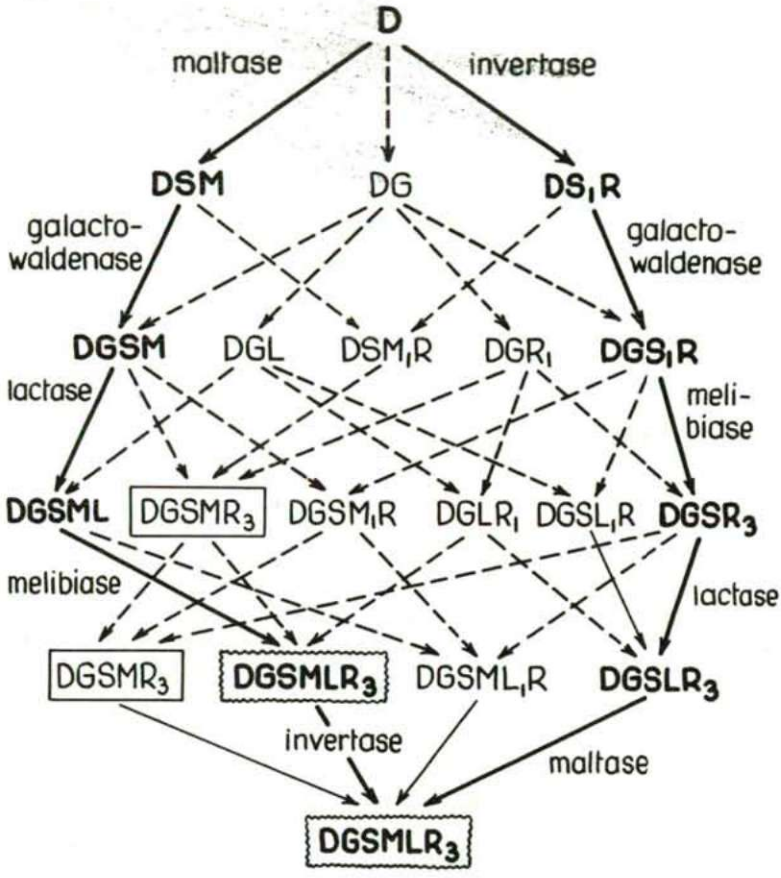


Figure 2/a. An explanation to Figure 3.

deduction represented in Figure 3 is satisfactory. Among others, it does not contain the combination DS.

As a new supposition was introduced the facultativity of raffinose splitting by invertase. This fourth deduction (Figure 4) seems, already conforming to the empirical data. In Table V the combinations of the four deductions are compared with the combinations described. Discrepancies between the combinations of the fourth deduction and the empirical combinations are explained as follows:

1) Reality of combination 18 ($DSMR_2$) is questionable. Only three species were characterized with this combinaton: *Schizosaccharomyces versatilis, Saccharomyces pastorianus, Zymodebaryomyces castellii.* One of the authors (N o v á k, 1959, 1960 b) experimentally demonstrated the $^1/_3$ raffinose fermentation of *Saccharomyces pastorianus.* This fact is supported by other authors too (V a s, 1960; K u d r i a v z e v, 1954, 1960, 1961). In the case of $^1/_3$ raffinose fermentation this combination becomes combination 17. which already corresponds to the suppositions.

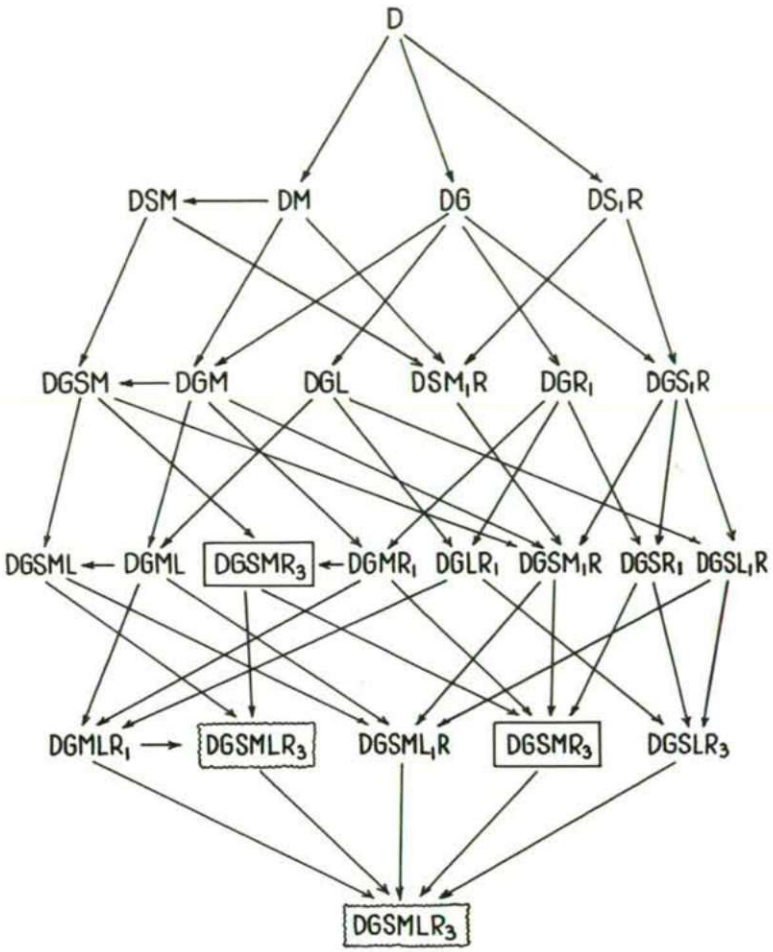


Figure 3. Third deduction of the sugar utilization combinations. Arrows from above downwards mean adding of a new enzyme. Horizontal arrows mean adaption of maltase to sucrose splitting.

2) Reality of combinaton 23 is improbable. It ferments galactose and so one can hardly believe in a $^2/_3$ raffinose fermentation. The melibiase is an exoenzyme (Novák, 1959, 1960 a, b; de la Fuente and Sols, 1958) and no mechanism is known which can distinguish between galactose supplied as such and galactose split off a raffinose molecule. *Candida melibiosi* Lodder et van Rij (1952) characterized with combinaton 23 was found by one of the authors (Novák, 1960 b, 1963) as a $^3/_3$ raffinose fermenter and it must be characterized with combination 24.

3) In the fourth deduction there are two combinations (21. $DGMLR_1$ and 26. $DGSLR_3$) not yet described.

In the first case there is no invertase and raffinose is split by melibiase. This possibility was discovered not long ago (*Saccharomyces oleaceus* Santa Maria, 1958 : DGR_1; *Saccharomyces oleaginosus* Santa Maria 1958 : $DGMR_1$; *Saccharomyces italicus* var. *melibiosi* van Uden et Assis-Lopez 1957 : $DGMR_1$; *Paratorulopsis melibiosi* (Shifrine et Phaff 1956) Novák et Zsolt 1961 : $DGLR_1$). The combination $DGMLR_1$ may be very rare and an organism with this spectrum was not yet found.

The lack of combination $DGSLR_3$ may be explained by the fact that it needs lactase and melibiase together, two enzymes rather rare for themselves.

In this way omitting from the list of the observed combinations the two probably wrong combinations and completing it with the two possible but not yet observed combinations a perfect agreement between observation and deduction can be obtained.

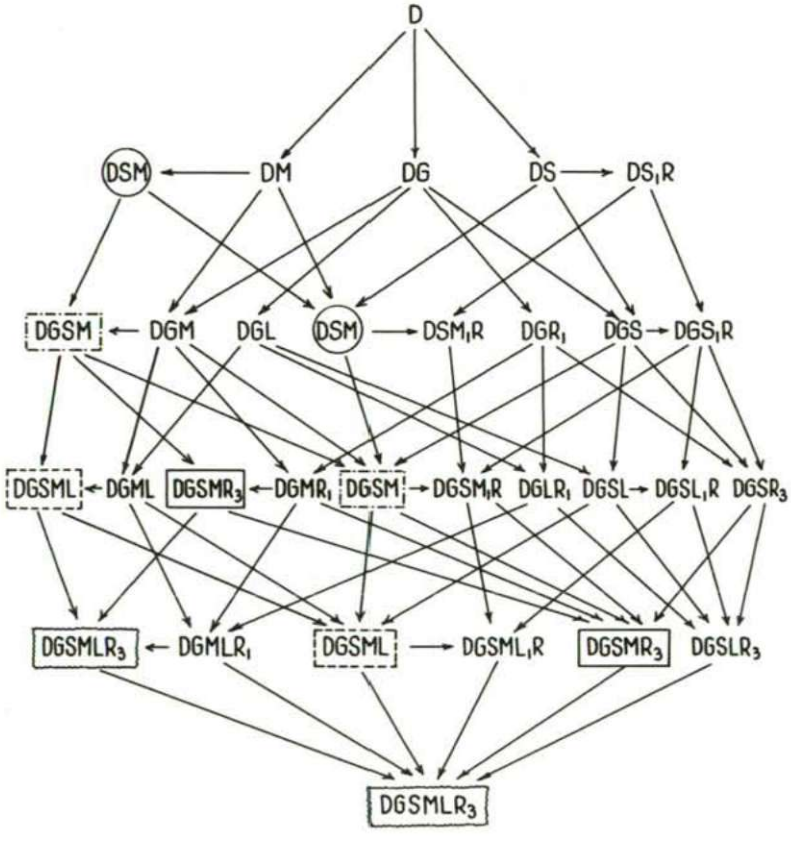


Figure 4. Fourth deduction of the sugar utilization combinations. Adaptation of maltase to sucrose splitting and adaptation of invertase to raffinose splitting were supposed. The identical framings mean appearance of a combination earlier.

Further factors influencing the sugar utilization combinations

Authors' fourth deduction (Figure 4) was performed supposing only hydrolytical splitting of the oligisaccharides. Other possibilities of splitting and the role of permeases will be taken into consideration in the following.

Phosphorolysis and polymerative cleavage of disaccharides and raffinose (the so-called direct oxydation and fermentation).

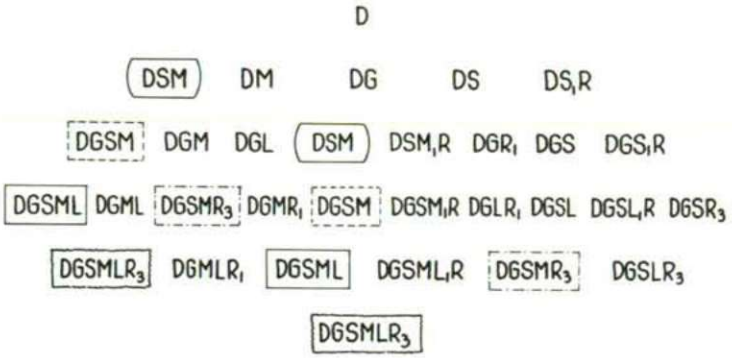


Figure 5. The revaluated deduced combinations.

Sobotka and Holzmann (1934), Willstätter and Bauman (1926), Willstätter and Rohderwald (1937), Willstätter and Steibelt (1920) demonstrated the polymerative splitting of maltose in yeasts with the enzyme amylomaltase. They demonstraed also that the maltase (α-glucosidase) content of som yeaests is not enough for the maltose fermentation measured and maltase is inactive below pH 5 but under this condition maltose was well fermented. Leibovitz and Hestrin (1939) demonstrated the pH-optimum of maltose fermentation; they found it between pH 5—6, an intervallum in which maltase is at most slightly active.

In bacteria two ways of non-hydrolytic maltose splitting was demonstrated. Monod and Torriani (1948, 1950), Doudoroff, Hassid, Putman, Potter and Lederberg (1949) demonstrated a polymerative splitting similar to that occuring in yeasts. In this case also the phosphorolytic splitting of the polyose was demonstrated.

Fitting and Sherp (1950, 1951, 1952 a, b), Fitting and Doudoroff (1952 a, b, c) found an enzyme splitting maltose into glucose and β-D-glucose-1-phosphate.

In *Aspergillus niger* the production of a non-fermentable and non-reducing trisaccharide (panose) was demonstrated from maltose (Pan et al., 1950).

Phosphorolysis of sucrose resulting in α-D-glucose-1-phosphate and fructose was demonstrated in bacteria (Doudoroff, 1943, 1945); Doudoroff, Barker and Hassid, 1947 a, b; Doudoroff,

TABLE V

Comparison of the described and the deduced combinations

combinations	occurrence			deductions			
	assimilation	fermentation	together	I	II	III	IV
1 D	31	47	+	+	+	+	+
2 DG	23	15	+	+	+	+	+
3 DS	3	9	+	−	−	−	+
4 DM	7	8	+	+	−	+	+
5 DGS	9	6	+	−	−	−	+
6 DGM	9	3	+	+	−	+	+
7 DGL	−	1	+	+	+	+	+
8 DGR_1	2	1	+	+	+	+	+
9 DSM	20	3	+	−	+	+	+
10 DS_1R	13	18	+	+	+	+	+
11 DGSM	40	13	+	−	+	+	+
12 DGSL	3	−	+	−	−	−	+
13 DGS_1R	12	13	+	+	+	+	+
14 $DGSR_3$		5	+	+	+	+	+
15 DGML	3	1	+	+	−	+	+
16 $DGMR_1$	1	1	+	+	−	+	+
17 DSM_1R		11	+	+	+	+	+
18 $DSMR_2$	13	3	+	−	−	−	−
19 $DGLR_1$	1	−	+	+	+	+	+
20 DGSML	23	−	+	−	+	+	+
21 $DGMLR_1$	−	−	−	+	−	+	+
22 $DGSM_1R$	1	17	+	+	+	+	+
23 $DGSMR_2$	38	1	+	−	−	−	−
24 $DGSMR_3$	1	4	+	+	+	+	+
25 $DGSL_1R$	7	5	+	+	+	+	+
26 $DGSLR_3$		−	−?	+	+	+	+
27 $DGSML_1R$	17 1	2	+	+	+	+	+
28 $DGSMLR_3$		−	+	+	+	+	+
number of types	22 26	22	26	20	18	23	26

Wianne, and Wolochok, 1949; Doudoroff, Hassid and Barker, 1944, 1947; Kagan et al., 1942).

Phosphorolysis of lactose producing α-D-glucose and galactose was demonstrated in bacteria (Novikova 1956 a, b). In yeasts this way is disputed (Willstätter and Oppenheimer, 1922; Roberts and McFarren, 1953; Kluyver and Custers, 1940; Rogosa, 1948).

Several other authors mention the possibility of splitting disaccharides through phosphorolysis or transglucosidation in bacteria and yeasts (Genevois, 1937; Willstätter and Steibelt, 1921; Doudoroff, 1940).

Several data about the so called direct fermentation belong to the problems of permeation. Mostly there is mentioned only the lack of extracellular splitting or wondering about the observation that a microorganism utilizes a disaccharide faster than its monosaccharide components. Phosphorolysis and polymerative splitting observed till now are intracellular processes but some of the hydrolytical splittings are also intracellular (e.g. maltose and lactose splitting by maltase and lactase respectively).

raffinose splitting in *Pseudomonas saccharophila*. It is performed by three enzymes: invertase, melibiase and sucrose ⟶ orthophosphate transglucosidase. All these enzymes are intracellular but the concentration of invertase is very low. Raffinose splitting begins with the aid of melibiase; the sucrose produced in this way is splitted mainly by sucrose-phosphorylase.

Phosphorylases and amylomaltase mentioned above are strictly specific (Willstätter and Rohderwald, 1937; Doudoroff, 1943; Doudoroff, Kaplan and Hassid, 1943).

Consequently supposition of phosphorolysis and polymerative splitting in the deductions means more specific enzymes. In this way sucrose utilization may become independent from maltose and raffinose utilization. This is already realized. although on an other basis, in the fourth deduction, and so it remains valid henceforward. Only the ways of origin of the different combinations must be revaluated. E.g. the combination DS is determined not by a strictly specific (raffinose not splitting) invertase but by sucrose-phosphorylase. The combinaton DM not by a strictly specific (sucrose not splitting) α-glucosidase but by a maltose-phosphorylase or amylomaltase. In this case the former cannot be adapted to raffinose splitting and the latter to sucrose splitting. The combination DS_1R supposes a non-specific invertase while DSM a non-specific α-glucosidase or the joint presence of sucrose-phosphorylase and maltose-phosphorylase (or amylomaltase). In the case of DS_1R two phosphorolytic enzymes were not supposed because phosphorolytic splitting of raffinose was not yet observed.

Problems of the permeation of sugars

Differences in the permeation of different sugars into yeasts were observed by Elliot (1949), Berger et al. (1958). Sols (1956) demonstrated that glucose, fructose and mannose were uptaken by a constitutive transportase (permease). According to Sols et al. (1958) the fermented sugars are transported actively without alteration or after extracellular hydrolysis their components are transported through the cell barriere. Fermented sugars have an affinity to the cells, competition was observed between different sugars and inhibition was found by non-fermented analogues. They demonstrated also that baker's yeast splits sucrose with the aid of invertase located in the cell wall and glucose and fructose produced in this way are transported („indirect" fermentation) while maltose is transported as such, is split intracellularly and thereafter fermented („direct" fermentation). Maltose-transportase is strictly specific while the α-glucosidase is not (it splits sucrose too). *Dekkeromyces fragilis* ferments lactose „directly", *Saccharomyces carlsbergensis* ferments melibiose „indirectly" (after extracellular hydrolysis). Latter results were confirmed by Novák (1959, 1960 a, b, 1961) too: in *Saccharomyces carlsbergensis* „indirect" raffinose, melibiose and sucrose fermentation, in *Saccharomyces pastorianus* „indirect" (but only $^1/_3$) raffinose fermentation, in *Candida pseudotropicalis* (imperfect form of *Dekkeromyces fragilis)* „direct" lactose fermentation, in *Candida*

solani „direct" sucrose fermentation was demonstrated. Avigad (1958) demonstrated a specific sucrose binding and an intracellular permeation barriere in yeasts.

Nelson et al. (1932) found invertase loosly bound in the cell wall (it can be demonstrated in the cell free extract) and therefore its activity is independent of the permeation of sucrose and raffinose.

In connection with trehalose Deere (1939) and Deere et al. (1939) observed that it was hydrolysed by dried yeast cells but not by the living ones.

TABLE VI

Fermentation of sucrose and maltose in the presence of specific transportases

α-glucosidase	sucrose-permease	maltose-permease	fermentation
+	+	−	ds
+	−	+	dm
+	+	+	dsm

As it was already mentioned in the case of phosphorolysis data about faster utilization of an oligosaccharide than its monosaccharide components or other data about the intact uptake of some oligosaccharides belong to the problems of permeability because sugars were uptaken actively with the aid of permeases (transportases) (Wright, 1936; Doudoroff, 1940; Leibovitz and Hestrin, 1942; Pelczar and Doetsch, 1949; Hassid, 1950).

Taking into consideration these data does not make necessary a change in the fourth deduction (Figure 4). Only some revaluations are necessary and these make some combinations more obvious. Viewing the combinations DM and DS and knowing the extracellular location of invertase, the sucrose splitting may be perfomed only by an α-glucosidase (because raffinose utilization is lacking). True enough, α-glucosidase splits sucrose and maltose alike. But sucrose and maltose have different and specific transportases and so lack of maltose-transportase may produce DS while lack of sucrose-transportase produces DM. The precence of both transportases results in DSM (Table VI).

Similarly, on a permeability basis, may be interpreted the sucrose and/or maltose containing combinations completed with galactose and lactose.

Permeability differences cause in the case of sucrose and maltose alternative utilization because here the α-glucosidase is constitutive (if inducible, both sugars may serve as inductor) but the necessary transportases are specific and can be induced only by the specific substrate. Therefore, in the case of organisms utilizing $^1/_3$ raffinose with the aid of melibiase the sucrose remains untouched because of lacking a sucrose-transportase (e.g. *Saccharomyces oleaginosus* Santa Maria, 1958).

Utilization of $^2/_3$ raffinose may hardly be explained supposing impermeability of galactose because correlation of the presence of the galactosidases and the galactose metabolizing enzyme complex (including the specific transportase) seems to be very strong (Losada, 1957).

Accordingly the combinations of the fourth deduction themselves, omitting the connecting arrows and giving other enzymological explanation of their origin, will remain correct (Figure 5).

Interpretation of the joint combinations of assimilation and fermentation

So far in the deductions assimilation and fermentation were not distinguished; both were considered as „utilization". Now an attempt will be made at the deduction and biochemical interpretation of the joint combinations of assimilation and fermentation.

TABLE VII/1

The deduced joint combinations. Reduction this number to 125 by considering the exo-enzyme nature of invertase and melibiase

combinations	A	B	C	combinations	A	B	C	combinations	A	B	C
D-	+	+	+	DGS_1R-d	−	+	−	DSM-ds	+	+	+
DG-	+	+	+	$DGSR_3$-d	−	−	−	DS_1R-ds	−	+	−
DS-	+	+	+	DGSL-d	+	+	+	DGS_1R-ds	−	+	−
DM-	+	+	+	DGML-d	+	+	+	$DGSR_1$-ds	−	+	−
DGS-	+	+	+	$DGMR_1$-d	+	−	−	$DGSR_3$-ds	−	−	−
DGM-	+	+	+	$DGLR_1$-d	+	−	−	DGSL-ds	+	+	+
DGL-	+	+	+	DSM_1R-d	−	+	−	DSM_1R-ds	−	+	−
DGR_1-	+	+	+	DGSML-d	+	+	+	DGSML-ds	+	+	+
DSM-	+	+	+	$DGSM_1R$-d	−	+	−	$DGSM_1R$-ds	−	+	−
DS_1R-	+	+	+	$DGSMR_3$-d	+	−	−	$DGSMR_3$-ds	+	−	−
DGSM-	+	+	+	$DGSL_1R$-d	−	+	−	$DGSL_1R$-ds	−	+	−
DGS_1R-	+	+	+	$DGSLR_3$-d	−	−	−	$DGSLR_3$-ds	+	−	−
$DGSR_3$-	+	+	+	$DGMLR_1$-d	+	−	−	$DGSML_1R$-ds	−	+	−
DGSL-	+	+	+	$DGSML_1R$-d	−	+	−	$DGSMLR_3$-ds	−	−	−
DGML-	+	+	+	$DGSMLR_3$-d	+	−	−	DM-dm	−	+	+
$DGMR_1$	+	+	+	DG-dg	+	+	+	DGM-dm	+	+	+
$DGLR_1$-	+	+	+	DGS-dg	+	+	+	DSM-dm	+	+	+
DSM_1R-	+	+	+	DGM-dg	+	+	+	DGSM-dm	+	+	+
DGSML-	+	+	+	DGL-dg	+	+	+	DGML-dm	+	+	+
$DGSM_1R$-	+	+	+	DGR_1-dg	+	−	−	$DGMR_1$-dm	+	−	−
$DGSMR_3$-	+	+	+	DGSM-dg	+	+	+	DSM_1R-dm	+	+	−
$DGSL_1R$-	+	+	+	DGS_1R-dg	−	+	−	DGSML-dm	+	+	+
$DGSLR_3$	+	+	+	$DGSR_3$-dg	−	−	−	$DGSM_1R$-dm	−	+	−
$DGMLR_1$-	+	+	+	DGSL-dg	+	+	+	$DGSMR_3$-dm	+	−	−
$DGSML_1R$-	+	+	+	DGML-dg	+	+	+	$DGMLR_1$-dm	+	−	−
$DGSMLR_3$-	+	+	+	$DGMR_1$-dg	+	−	−	$DGSML_1R$-dm	−	+	−
D-d	+	+	+	$DGLR_1$-dg	+	−	−	$DGSMLR_3$-dm	+	−	−
DG-d	+	+	+	DGSML-dg	+	+	+	DGS-dgs	+	+	+
DS-d	+	+	+	$DGSM_1R$-dg	−	+	−	DGSM-dgs	+	+	+
DM-d	+	+	+	$DGSMR_3$-dg	+	−	−	DGS_1R-dgs	−	+	−
DGS-d	+	+	+	$DGSL_1R$-dg	−	+	−	$DGSR_3$-dgs	−	−	−
DGM-d	+	+	+	$DGSLR_3$-dg	−	−	−	DGSL-dgs	+	+	+
DGL-d	+	+	+	$DGMLR_1$-dg	+	−	−	DGSML-dgs	+	+	+
DGR_1-d	+	−	−	$DGSML_1R$-dg	−	+	−	$DGSM_1R$-dgs	−	+	−
DSM-d	+	+	+	$DGSMLR_3$-dg	+	−	−	$DGSMR_3$-dgs	+	−	−
DS_1R-d	−	+	−	DS-ds	+	+	+	$DGSL_1R$-dgs	−	+	−
DGSM-d	+	+	+	DGS-ds	+	+	+	$DGSLR_3$-dgs	−	−	−

A = invertase, B = melibiase, C = invertase + melibiase.

The 26 combinations deduced above were combined: 26 assimilation combinations with 27 fermentation combinations (case 27. represents non-fermenters).

(In the followings, assimilation of sugars will be designated with majuscules while fermentation with the corresponding minuscules.)

The restriction that the members of the fermentation combination must be represented in the assimilation combination was taken into consideration. Calculation results in 221 joint combinations (Table VII). But only 71 combinations were observed and described!

It is obvious that fermenting yeasts assimilating raffinose by invertase or melibiase (and at present no other raffinose splitting enzyme is known) will also ferment raffinose. The reason for this is that both invertase and melibiase are exoenzymes. Therefore differences in aerobic and anaerobic permeation, producing DGSM-dm, DGSM-ds etc. combinations in yeasts with the endoenzyme α-glucosidase (e.g. Novák et al., 1965 a, b, c), are here without any significance. This means that combinations as DS_1R-d, DG_1R-d, DSM_1R-dm etc. are impossible. Data of van Uden and do Carmo-Sousa (1957) and Vörös-Felkai and Novák (1960) about investigation of 18 species and 268 strains of 41 species respectively support this idea: in all cases raffinose assimilation and raffinose fermentation were strictly correlated.

With the aid of this rule the number of the possible joint combinations became 125 (Table VII).

TABLE VII/2. (continued)

combinations	A	B	C	combinations	A	B	C	combinations	A	B	C
$DGSML_1R$-dgs	−	+	−	$DGSMLR_3$-dsm	+	−	−	$DGMLR_1$-dgml	+	−	−
$DGSMLR_3$-dgs	+	−	−	DS_1R-ds_1r	+	+	+	$DGSML_1R$-dgml	−	+	−
DGM-dgm	+	+	+	DGS_1R-ds_1r	+	+	+	$DGSMLR_3$-dgml	+	−	−
DGSM-dgm	+	+	+	$DGSR_3$-ds_1r	+	−	−	$DGMR_1$-$dgmr_1$	+	+	+
DGML-dgm	+	+	+	DSM_1R-ds_1r	+	+	+	$DGSMR_3$-$dgmr_1$	+	+	+
$DGMR_1$-dgm	+	−	−	$DGSM_1R$-ds_1r	+	+	+	$DGMLR_1$-$dgmr_1$	+	+	+
DGSML-dgm	+	+	+	$DGSMR_3$-ds_1r	+	−	−	$DGMLR_3$-$dgmr_1$	+	+	+
$DGSM_1R$-dgm	−	+	−	$DGSL_1R$-ds_1r	+	+	+	$DGLR_1$-$dglr_1$	+	+	+
$DGSMR_3$-dgm	+	−	−	$DGSLR_3$-ds_1r	+	−	−	$DGSLR_3$-$dglr_1$	+	+	+
$DGMLR_1$-dgm	+	−	−	$DGSML_1R$-ds_1r	+	+	+	$DGMLR_1$-$dglr_1$	+	+	+
$DGSML_1R$-dgm	−	+	−	$DGSMLR_3$-ds_1r	+	−	−	$DGSMLR_3$-$dglr_1$	+	+	+
$DGSMLR_3$-dgm	+	−	−	DGSM-dgsm	+	+	+	DSM_1R-dsm_1r	+	+	+
DGL-dgl	+	+	+	DGSML-dgsm	+	+	+	$DGSM_1R$-dsm_1r	+	+	+
DGSL-dgl	+	+	+	$DGSM_1R$-dgsm	−	+	−	$DGSMR_3$-dsm_1r	+	−	−
DGML-dgl	+	+	+	$DGSMR_3$-dgsm	+	−	−	$DGSML_1R$-dsm_1r	+	+	+
$DGLR_1$-dgl	+	−	−	$DGSML_1R$-dgsm	−	+	−	$DGSMLR_3$-dsm_1r	+	−	−
DGSML-dgl	+	+	+	$DGSMLR_3$-dgsm	+	−	−	DGSML-dgsml	+	+	+
$DGSL_1R$-dgl	−	+	−	DGS_1R-dgs_1r	+	+	+	$DGSML_1R$-dgsml	−	+	−
$DGSLR_3$-dgl	−	−	−	$DGSR_3$-dgs_1r	+	−	−	$DGSMLR_3$-dgsml	+	−	−
$DGMLR_1$-dgl	+	−	−	$DGSM_1R$-dgs_1r	+	+	+	$DGSM_1R$-$dgsm_1r$	+	+	+
$DGSML_1R$-dgl	−	+	−	$DGSMR_3$-dgs_1r	+	−	−	$DGSMR_3$-$dgsm_1r$	+	−	−
$DGSMLR_3$-dgl	+	−	−	$DGSL_1R$-dgs_1r	+	+	+	$DGSML_1R$-$dgsm_1r$	+	+	+
DGR_1-dgr_1	+	+	+	$DGSLR_3$-dgs_1r	+	−	−	$DGSMLR_3$-$dgsm_1r$	+	−	−
$DGSR_3$-dgr_1	+	+	+	$DGSML_1R$-dgs_1r	+	+	+	$DGSMR_3$-$dgsmr_3$	+	+	+
$DGMR_1$-dgr_1	+	+	+	$DGSMLR_3$-dgs_1r	+	+	−	$DGSMLR_3$-$dgsmr_3$	+	+	+
$DGLR_1$-dgr_1	+	+	+	$DGSR_3$-$dgsr_3$	+	+	+	$DGSL_1R$-$dgsl_1r$	+	+	+
$DGSMR_3$-dgr_1	+	+	+	$DGSMR_3$-$dgsr_3$	+	+	+	$DGSLR_3$-$dgsl_1r$	+	−	−
$DGSLR_3$-dgr_1	+	+	+	$DGSLR_3$-$dgsr_3$	+	+	+	$DGSML_1R$-$dgsl_1r$	+	+	+
$DGMLR_1$-dgr_1	+	+	+	$DGSMLR_3$-$dgsr_3$	+	+	+	$DGSMLR_3$-$dgsl_1r$	+	−	−
$DGSMLR_3$-dgr_1	+	+	+	DGSL-dgsl	+	+	+	$DGSLR_3$-$dgslr_3$	+	+	+
DSM-dsm	+	+	+	DGSML-dgsl	+	−	+	$DGSMLR_3$-$dgslr_3$	+	+	+
DGSM-dsm	+	+	+	$DGSL_1R$-dgsl	−	+	−	$DGMLR_1$-$dgmlr_1$	+	+	+
DSM_1R-dsm	−	+	−	$DGSLR_3$-dgsl	−	−	−	$DGSMLR_3$-$dgmlr_1$	+	+	+
DGSML-dsm	+	+	+	$DGSML_1R$-dgsl	−	+	−	$DGSML_1R$-$dgsml_1r$	+	+	+
$DGSM_1R$-dsm	−	+	−	$DGSMLR_3$-dgsl	+	−	−	$DGSMLR_3$-$dgsml_1r$	+	−	−
$DGSMR_3$-dsm	+	−	−	DGML-dgml	+	+	+	$DGSMLR_3$-$dgsmlr_3$	+	+	+
$DGSML_1R$-dsm	−	+	−	DGML-dgml	+	+	+				

A = invertase, B = melibiase, C = invertase + melibiase.

The 125 deduced and the 71 described joint combinations are compared in Table VIII.

(Originally 73 combinations were described, but three combinations containing $^2/_3$ raffinose utilization were corrected according to the ideas expressed in the foregoings; after this correction two of these combinations turn into already described ones [DGSMN-dgsmr$_2$ ⟶ DGSMR$_3$-dgsmr$_3$; DSMR-dsmr$_2$ ⟶ DSM$_1$R-dsm$_1$r) while the third became a new one (DGSMLR-dsmr$_2$ ⟶ DGSML$_1$R-dsm$_1$r]).

The quantitative and partly the qualitative discrepancies between deduction and observation will be explained in the following.

Combinations deduced but not yet described

Table VIII contains only combinations included authors' previous paper (Novák and Zsolt, 1961). Since then many new species were

TABLE VIII/1

Comparison of deduced and described joint combinations

combinations	occurrence number of species	deduction	combinations	occurrence number of species	deduction
D-	13	+	DGL-d	—	+
DG-	9	+	DSM-d	9	+
DS-	1	+	DGSM-d	4	+
DM-	—	+	DGSL-d	—	+
DGS-	4	+	DGML-d	—	+
DGM-	1	+	DGSML-d	2	+
DGL-	—	+	DG-dg	6	+
DGR$_1$-	1	+	DGS-dg	—	+
DSM-	9	+	DGM-dg	1	+
DS$_1$R-	—	+	DGL-dg	—	+
DGSM-	14	+	DGSM-dg	5	+
DGSL-	—	+	DGSL-dg	1	+
DGS$_1$R-	2	+	DGML-dg	—	+
DGSR$_3$-		+	DGSML-dg	2	+
DGML-	2	+	DS-ds	1	+
DGMR$_1$-	—	+	DGS-ds	3	+
DGLR$_1$-	1	+	DSM-ds	1	+
DSM$_1$R-	—	+	DS$_1$R-ds	2	—
DGSML-	15	+	DGSM-ds	1	+
DGSM$_1$R-	1	+	DGSL-ds	—	+
DGSMR$_3$-	8	+	DGSML-ds	1	+
DGSL$_1$R-	1	+	DM-dm	4	+
DGSLR$_3$-		+	DGM-dm	4	+
DGMLR$_1$-	—	+	DSM-dm	—	+
DGSML$_1$R-	1	+	DGSM-dm	—	+
DGSMLR$_3$-	7	+	DGML-dm	—	+
D-d	18	+	DGSML-dm	—	+
DG-d	8	+	DGS-dgs	2	+
DS-d	1	+	DGSM-dgs	3	+
DM-d	3	+	DGSL-dgs	1	+
DGS-d	—	+	DGSML-dgs	—	+
DGM-d	2	+	DGM-dgm	1	+

described, some of them characterized with combinations indicated in Table VIII still as „deduced". E.g.:

1. DM ——. Described in connection with *Trichosporon figueriae* Batista et Silveira 1960.

2. Combination DGSML —— was described by Novák and Vörös-Felkai (1962) *(Rhodotorula slooffii).*

(Debaryomyces artagaveytiae Batista, Silveira et Coelho 1961 with the combination DGSL —— could not be considered due to lacking of raffinose tests.)

3. DGS-d was observed by Novák (1961) *(Candida requinyii* Szép et Novák 1962).

4. DGS-dg was described by Batista, Campos et Coelho (1960) *(Endomycopsis dermatensis).*

5. DSM-dm was described as characteristic to *Procandida grubyi* Novák, Vitéz et Marton 1961.

TABLE VIII/2. (continued)

combinations	occurrence number of species	deduction	combinations	occurrence number of species	deduction
DGSM-dgm	2	+	$DGSMR_3$-$dgsr_3$	3	+
DGML-dgm	—	+	$DGSLR_3$-$dgsr_3$	—	+
DGSML-dgm	—	+	$DGSMLR_3$-$dgsr_3$	—	+
DGL-dgl	—	+	DGSL-dgsl	—	+
DGSL-dgl	1	+	DGSML-dgsl	—	+
DGML-dgl	—	+	DGML-dgml	1	+
DGSML-dgl	—	+	DGSML-dgml	—	+
DGR_1-dgr_1	1	+	$DGMR_1$-$dgmr_1$	1	+
$DGMR_1$-dgr_1	—	+	$DGSMR_3$-$dgmr_1$	—	+
$DGSR_3$-dgr_1	—	+	$DGMLR_1$-$dgmr_1$	—	+
$DGLR_1$-dgr_1	—	+	$DGSMLR_3$-$dgmr_1$	—	+
$DGSLR_3$-dgr_1	—	+	$DGLR_1$-$dglr_1$	—	+
$DGSMR_3$-dgr_1	—	+	$DGSLR_3$-$dglr_1$	—	+
$DGMLR_1$-dgr_1	—	+	$DGMLR_1$-$dglr_1$	—	+
$DGSMLR_3$-dgr_1	—	+	$DGSMLR_3$-$dglr_1$	—	+
DSM-dsm	1	+	DSM_1R-dsm_1r	11	+
DGSM-dsm	2	+	$DGSM_1R$-dsm_1r	2	+
DGSML-dsm	—	+	$DGSML_1R$-dsm_1r	1	+
DS_1R-ds_1r	11	+	DGSML-dgsml	—	+
DGS_1R-ds_1r	1	+	$DGSM_1R$-$dgsm_1r$	14	+
DSM_1R-ds_1r	2	+	$DGSML_1R$-$dgsm_1r$	3	+
$DGSM_1R$-ds_1r	4	+	$DGSMR_3$-$dgsmr_3$	4	+
$DGSL_1R$-ds_1r	—	+	$DGSMLR_3$-$dgsmr_3$	1	+
$DGSML_1R$-ds_1r	—	+	$DGSL_1R$-$dgsl_1r$	3	+
DGSM-dgsm	9	+	$DGSML_1R$-$dgsl_1r$	2	+
DGSML-dgsm	3	+	$DGSLR_3$-$dgslr_3$	—	+
DSML(R)-dgsm	1	—	$DGSMLR_3$-$dgslr_3$	—	+
DGS_1R-dgs_1r	7	+	$DGMLR_1$-$dgmlr_1$	—	+
$DGSM_1R$-dgs_1r	3	+	$DGSMLR_3$-$dgmlr_1$	—	+
$DGSL_1R$-dgs_1r	3	+	$DGSML_1R$-$dgsml_1r$	2	+
$DGSML_1R$-dgs_1r	—	+	$DGSMLR_3$-$dgsmlr_3$	—	+
$DGSR_3$-$dgsr_3$	2	+			

6. DGSM-dm characterizes *Kloeckera faecalis* Batista et Silveira 1959.

7. DGSML-dgs was observed on *Endomycopsis interdigitalis* Batista et Coelho 1960.

8. $DGSR_3$-dgr_1 was observed on some atypical strains of *Saccharomyces oleaceus* by Santa Maria (1958).

9. DGSML-dsm was observed by Lodder and Kreger van Rij (1952) on some strains of *Debaryomyces subglobosus.*

10. $DGSL_1R$-ds_1r was observed by Vörös-Felkai and Novák (1962) on a *Torulopsis strain* (No. 58/316 OKI).

11. $DGSML_1R$-ds_1r was observed by Lodder and Kreger van Rij (1952) on some *Saccharomyces polymorphus* strains.

12. $DGSML_1R$-dgs_1r was described by Capriotti (1961) as characteristic to *Debaryomyces cantarellii.*

13. $DGSMR_3$-$dgmr_1$ was observed by Santa Maria (1958) on some atypical *Saccharomyces oleaginosus* strains.

With these 13 combinations the number of the observed ones became 84.

Insufficiencies in the investigation of raffinose utilization

Several descriptions contain no data about raffinose assimilation, sometimes also data about raffinose fermentation are lacking. Performing additionally the raffinose tests it may be expected that some species will be recognized as belonging to not yet described combinations. E.g.:

1. *Sporobolomyces odorus* described as DS —— may become DS_1R ——. (Combinations DS —— will not be eliminated through this; atypical strains of *Prosporobolomyces salmonicolor* showing DS —— will replace it.)

2. The combinations DGS_1R —— and $DGSR_3$ —— may be emerged as characteristic to *Paratorulopsis apis* and *Rhodotorula minuta* described both with the combination DGSR ——. The same may be expected about *Endomyces ovetensis, Prosporobolomyces salmonicolor, Sporobolomyces odorus, Rhodotorula graminis, Dioszegia hungarica.*

3. Similarly some of the species described with the combination DSM —— *(Endomycopsis bispora, Azymohansenula canadensis, Prosporobolomyces holsaticus, Sporobolomyces boleticolus, Bullera grandispora, Trichosporon cutaneum, Azymocandida japonica, Azymoprocandida mesenterica)* may have the combination DSM_1R.

Rhodotorula texensis (DGSLR ——) was considered as $DGSL_1R$; transferring it to $DGSLR_3$ —— would give no use.

4. As $DGSMR_3$-dgr_1 may be expected, after additional performing of the raffinose tests, *Fermentotrichon hellenicum* described as DGSM-dg.

5. Similarly *Fermentotrichon intermedium* (DGSML-dg) may reveal itself as $DGSMLR_3$-dgr_1.

In several other cases completion of the raffinose tests may improve the qualitative picture without any gain, however, from the quantitative point of view. E.g.:

Cryptococcus gastricus (DGM ——) may be in reality $DGMR_1$ —— but hereby DGM —— will be lost.

Two species described as DGML —— *(Trichosporon infestans* and *Cryptococcus terreus)* may be in reality $DGMLR_1$ ——; this possibility will not be taken into consideration being combination $DGMLR_1$ not yet observed (see later!).

Brettanomyces anomalus (DGSL-dgl) has perhaps the combination $DGSLR_3$-$dglr_1$; but hereby DGSL-dgl will be lost.

With these the number of the possible joint combinations became 89.

Explanation of further discrepancies

It was supposed that the occurence of many combinations has a very low probability: this is the cause that they are not yet discovered.

Joint combinations containing combinations not yet observed

These are the following 12 joint combinations containing the combinations $DGSLR_3$ and $DGMLR_1$ not yet observed:

$DGSLR_3$ ——, $DGMLR_1$ ——, $DGSLR_3$-dgr_1, $DGMLR_1$-dgr_1, $DGSLR_3$-$dgsr_3$, $DGMLR_1$-$dgmr_1$, $DGSLR_3$-$dglr_1$, $DGMLR_3$-$dglr_1$ $DGSLR_3$-$dgslr_3$, $DGSMLR_3$-$dgslr_3$, $DGMLR_1$-$dgmlr_1$, and $DGSMLR_3$-$dgmlr_1$.

Nothing could be said against the possibility of these joint combinations. They contain two very rare properties (lactose and melibiose splitting) the joint occurrence of which has only an extremly low probability.

With these the number of possibly occurring cases became 101.

Lactose assimilation and fermentation

The well-known rare occurrence of the two properties may explain the lack of further 24 joint combinations:

DGL-dgl, DGML-dgl, DGSML-dgl, DGSL-dgsl, DGSML-dgsl, DGSML-dgml, $DGLR_1$-$dglr_1$, $DGSMLR_3$-$dglr_1$, DGSML-dgsml, and $DGSMLR_3$-$dgslr_3$ with lactose fermentation and DGL ——, DGL-d, DGSL ——, DGSL-d, DGL-dg, DGML-dg, DGSL-ds, DGML-dm, DGSML-dm, DGML-dgm, DGSML-dgm, $DGLR_1$-dgr_1, $DGSMLR_3$-$dgsr_3$, and $DGSMLR_3$-$dgmr_1$ with lactose assimilation.

With these the number rises to 125.

Rarity of the combination $DGMR_1$

This combination was only once observed *(Saccharomyces oleaginosus* Santa Maria, 1958). This makes comprehensible that combinations $DGMR_1$ —— and $DGMR_1$-dgr_1 are not yet observed.

With these the possibility of 127 joint combinations may be expected.

About combinations incongruent with the deduction

According to the foregoings the number of described and probably occuring combinations is 127. This is higher than the number of the deduced combinations (125). This discrepancy is caused by two combinations (DS_1R-ds and DGSMLR-dgsm) the reality of which is doubtful due to their raffinose assimilation without raffinose fermentation. Only one species was described with the latter combination *(Candida pseudotumoralis)* with a comment on week raffinose assimilation. With the other combination only two species were characterized *(Torulopsis apicola* and *Zymodebaryomyces globosus).*

Conclusions

The deduction of the sugar utilization combinations was based on data known about the enzymes participating in the metabolism of the diagnostic sugars. The fact, that a larger part of them are not yet observed has no enzymological basis. Rare occurrence of lactose and melibiose splitting must have a phylogenetical explanation in connection with the rare occurrence of the sugars in question.

Authors' outlined deduction seems to be a rather useful working hypothesis. Most of the data published after accomplishing this article can be fitted in without any difficulty; the deduced combinations, so to say, predicted future observations.

Naturally, no theoretical deductions can replace observation and experimentation. Some of authors' investigations demonstrated that reality is more complicated than the theoretical scheme. E.g.: separate endoenzymes for maltose and sucrose splitting were found in *Procandida albicans* (Novák and Zsolt 1963). Maltose splitting exoenzyme was also demonstrated (Novák et al., 1966).

A promising possibility for discovering new sugar splitting enzymes are offered by organisms which show utilization patterns incongruent with authors' deduction. E.g. *Saccharomyces inusitatus* with its $^2/_3$ raffinose fermentation (van der Walt, 1965) or *Saccharomyces hienipiensis* Santa Maria (1962) and *Saccharomyces norbensis* Santa Maria (1963) utilizing melibiose but not raffinose etc.

Summary

Utilization (assimilation and fermentation) combinations of the six diagnostic sugars generally used in yeast taxonomy were interpreted on the basis of present-day enzymological data.

26 combinations of assimilation and 27 combinations of fermentation and from these 125 joint combinations were deduced.

Agreement between the deduction and the observed data was demonstrated and discrepancies were explained. The deduction may be considered as a useful working hypothesis in yeast taxonomy and enzymology alike.

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ÜBER EINIGE MORPHOLOGISCHE UND PHYSIOLOGISCHE EIGENSCHAFTEN DER MITTELS COLCHICINBEHANDLUNG INDUZIERTEN TETRAPLOIDEN PAPRIKAPFLANZEN

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Einleitung

Ungarische Forscher haben auf dem Gebiete der Paprikaveredlung ausgezeichnete Erfolge erzielt. Sie haben Gewürzpaprikasorten mit hohem Farbstoffgehalt entwickelt. Diese Sorten enthielten jedoch beträchtliche Mengen Capsaicin, dadurch ging ihre Verarbeitung mit ziemlich vielen Schwierigkeiten einher. E. Obermeyer brachte durch Kreuzung einer Speisepaprika- mit einer Gewürzpaprikasorte eine capsaicinfreie Gewürzpaprikavariante zustande. Im weiteren entstanden — ausgehend von dieser Sorte — durch Auswahl und Kreuzung mehrere capsaicinfreie Sorten. Der Farbstoffgehalt der capsaicinhaltigen Sorten ist jedoch bis auf den heutigen Tag grösser als jener der Capsaicin nicht enthaltenden Sorten. Es erschien daher zweckmässig, mit einem von den bisherigen Veredlungsmethoden abweichenden Verfahren Versuche zur Herstellung neuerer, die bisheringen an Qualität übertreffender Sorten zu unternehmen. Da es sich bei sämtlichen in der öffentlichen Züchtung befindlichen Paprikasorten um diploide Varianten handelt, dachten wir daran, es mit colchicininduzierten polyploiden Sorten zu versuchen. Es gelang uns bereits zweimal, tetra- bzw. oktoploide Pflanzen zu entwickeln (Pálfi et al., 1961; Pálfi, 1965). Im Jahre der Behandlung ging die Mehrzahl der stark vergifteten, physiologisch in geschwächtem Zustand befindlichen Pflanzen infolge der ungünstigen Kultur- und Witterungsverhältnisse noch vor Erreichung des Fruchtstandes ein. Ein ähnliches Schicksal harrte auch der Nachkommen der samentragenden Pflanzen.

In den vorliegenden Versuchen wird erneut mittels Colchicinbehandlung die Hervorbringung einer erblich — polyploiden Paprikavariante angestrebt. In den folgenden Jahren sollen dann die morphologischen, physiologischen und Veredlungseigenschaften der diploiden

Ausgangs- und der erhaltenen polyploiden Sorte vergleichend untersucht werden. Die im Jahre der Colchicinbehandlung beobachteten Wachstums- und Entwicklungsunterschiede sind bereits untersucht worden (Pálfi 1965) und haben zu der Feststellung geführt, dass sie vorwiegend Folge der Colchicinwirkung sind und nur zu einem kleineren Teil die polyploiden Eigenschaften zeigen. Wir fanden — und auch Bolli (1965) teilte mit —, dass das Colchicin seine bedeutende Wirkung auf dem Wege einer gewissen Enzymtätigkeit entfaltet, wodurch es zu einem erheblichen Ansteig der freien K^+- und Na^+-Ionenmenge kommt. Die vielen einwertigen Kationen bringen Änderungen im Wassersättigungszustande des Zytoplasmas und der Zellwände mit sich und induzieren deren beträchtliche Volumvergrösserung. Diese gesteigerte Wassersättigung wird durch Zunahme des schwach gebundenen Wassers verwirklicht.

Im Jahre der Colchicinbehandlung wiesen die einzelnen Pflanzen — neben stark verzögertem Wachstum und schwacher Entwicklung — Missbildungen auf, so dass erst die nächsten Generationen den polyploiden Charakter zeigen können. Zur Ausgleichung der infolge der Genomvermehrung gestörten inneren Verhältnisse bedarf es mehrerer Generationen, wonach dann die geschwächte Vitalität wiederhergestellt werden kann.

Rampal (1965) hat den Vitamin C-Gehalt normaler und cholchicinbehandelter Tetraploide capsaicinhaltiger Paprikapflanzen untersucht. Für die Diploide ergaben sich Durchschnittswerte von 60 mg/100 g und für die tetraploiden Pflanzen von 95 mg/100 g. Die Vitamin C-Menge hatte also mit der Verdoppelung der Chromosomenzahl weitgehend zugenommen. Dies lässt auch an die Möglichkeit eines sprunghaften Anstieges anderer wertvollen Eigenschaften, wie z.B. Farbstoffgehalt, Vitamine, Aroma und aetherische Stoffe denken. Unterstützt wird diese Vermutung durch die Feststellung von Heslot und Ferrary (1959), wonach die Tetraploide nicht selten mit Mutationen einhergeht. Nach Stebbine (1966) sichert die Polyploide in der terminalen Phase der Evolution höherer Pflanzen die ökologische und physiologische Spezialisation und die genetische Differenzierung.

Material und Methodik

Die diploide Ausgangspflanze war die von I. Erdei veredelte, capsaicinfreie Paprikasorte 57—13 (*Capsicum annuum* L. var. *longum*, forma *Szegediense*). Zur Colchicinbehandlung wurden die Samen in mit der Erde gefüllte Kulturgefässe gesät (10. März 1966), welche unmittelbar nach der erfolgten Behandlung ins Freie gebracht und für die Nacht mit Folie bedeckt wurden. Mit der Behandlung wurde begonnen, wenn bei einigen Pflanzen zwischen den Keimblättchen der Ansatz des Vegetationssprosses erschien. Die Kulturgefässe und die darunter befindliche Erde wurden reichlich begossen, zwischen die Keimblättchen drei Tage hindurch täglich dreimal 0,2 %-ige Colchicinlösung geträufelt, von nun an der Boden unter den Kulturgefässen ständig begossen und die Gefässe mit durchsichtiger Folie bedeckt, um ein Verdunsten der Colchicintröpfchen in der feuchten Atmosphäre zu verhüten. Nach Ablauf von drei Tagen wurden die Pflanzen abgewaschen, begossen und auch weiterhin im Sonnenlicht gehalten — bei kaltem Wetter wurden sie mit Folie überdeckt. Inzwischen fand auch Begiessen mit Nährlösung statt. 2—3 Wochen lang entwickelte sich der Vegetationsspross nicht, nur die Keim-

blättchen und das Hypokotyl wurden grösser und dicker. Dann erschienen die Laubblätter, aber die Pflanzen blieben auch weiterhin zwergenwüchsig. Bis zur Erreichung von 6—8 Blättern gingen etwa 20 % der Pflanzen ein. Die übriggebliebenen Pflanzen wurden nun in den Überschwemmungsboden des Botanischen Gartens unserer Universität gepflanzt. Beim Erscheinen der ersten Blüten wurden — je nach dem Habitus der Pflanzen bzw. auf Grund der Grösse der Blüten und der Staubgefässe — die Diploide herausgezupft (ca. 20 %). Nach dem weiteren Untergang blieben bis zur Fruchtreife von den ausgesetzten Pflanzen etwa 50 % am Leben. Besonders die Oktoploide gingen zugrunde. Nach dem Abernten der Früchte und deren Nachreifung wurden die Kerne einer jeden Frucht in gesonderte Säckchen bzw. Tüten gegeben. Die einzelnen Schoten enthielten gewöhnlich nur 10—20 entwickelte Samen. Von den Samen der einzelnen Früchte wurden einige in Petrischalen zum Keimen gebracht und aus dem Meristem der nur noch rund 2 mm grossen Würzelchen Chromosomenzählungen vorgenommen. Zwecks Verkürzung und Streckung der Chromosomen wurden die Keime für drei Stunden in einer 8—8—0 xychinolin-Lösung von 0,0015 Mol oder zwei Stunden in 0,2 %-iger wässeriger Colchicinlösung inkubiert (Vorbehandlung).

Nun wurden die Würzelchen in Carnoy-II-Lösung fixiert, dann die Zellen der Gewebe mit einem Salzsäure-Alkoholgemisch (1:2) aufgelockert, auf dem Objektträger mit Carmin-Essigsäure gefärbt und nach Abdecken mit Schmidt'scher Verschlussmasse Chromosomenzählung in der Phasenkontrasteinrichtung mit Ölimmersion bei 1250-facher Vergrösserung vorgenommen. Rund 70 % der Früchte erwiesen sich als Tetraploide, zur Weiterzüchtung wurden nur sicher tetraploide Exemplare verwendet.

Da die Keimfähigkeit der Tetraploidsamen eine sehr schlechte war, haben wir sie im Frühjahr 1967 in Petrischälchen auf feuchtem Filtrierpapier unter optimalen Bedingungen zum Keimen angesetzt, die über Keimblätter verfügenden Pflänzchen in Treibhaus-Stecklingsbeete gepflanzt und die grösseren Pflänzchen später in den guten Boden der Veredelungsanlage der Landwirtschaftlichen Versuchsanstalt übertragen. Gleichzeitig wurden auch mehrere hundert diploide Pflänzchen der gleichen Ausgangssorte als Kontrollen der tetraploiden ausgepflanzt. Im Sommer 1967 herrschte 5—6 Wochen lang heisse, trockene Witterung mit Tagestemperaturen von 30—35° C. Während dieser Zeit wurden di- und tetraploiden Pflänzchen gleichermassen gut begossen.

Für die morphologischen Untersuchungen wurden am 25. Juli bei vollem Blütenstand Proben entnommen. Zum Vergleich der diploiden und der tetraploiden Paprikapflanzen (zweite Generation; C_1) wurden das sechste Internodium Blätter der Seitenzweige I. Ordnung und die Stiele dieser Blätter verwendet.

Das gesammelte Material wurde in 50 %-igem Aethanol fixiert, in Zelloidin eingebettet, im Mikrotom von jedem Organ 50 Querschnitte angefertigt, diese mit Delafield'schem saurem Hämatoxylin gefärbt und nach Abschliessen mit Kanadabalsam untersucht.

Zu den blatthistologischen Untersuchungen wurde das mittlere Drittel der Blattlamellen benutzt, da die Arten- und Sorteneigenschaften an diesen Stellen am ehesten zur Geltung kommen. Das Anteilsverhältnis der einzelnen Gewebe der untersuchten Organe wurde an aus dem Mikroskop projizierten Präparaten planimetrisch bestimmt.

Zur physiologischen Bewertung wurden zwei Wochen nach der Auspflanzung — und von da an 12 Wochen hindurch wöchentlich — Blätter aus den Verzweigungen am mittleren Drittel des Stengels gesammelt. Bei einem Teil der Blätter wurde das Gewicht frisch, sowie nach dem Trocknen bei 65° ermittelt (Lufttrockengewicht). Dünnschichtchromatographisch wurden die Farbstoffkomponenten der Chloroplasten der frischen Blätter und die Gesamtchlorophyllmenge bestimmt. Ebenfalls aus Frischmaterial wurde auch der Gehalt an löslichen Gesamtproteinen nach Lowry et al. (1951) nachgewiesen. Die Bestimmung der Aminosäuren erfolgte auf schicht- und papierchromatographischem Wege — ausgehend vom Lufttrockengewicht — und die des Gesamtaminosäurengehaltes mit dem Universal-Standardverfahren mittels Eluierung (Szalai, 1967; Pálfi, 1964). Als Solventien dienten: Butanol-Essigsäure-Wasser (2:1:1) und Phenol-Alkohol-Wasser (3:1:1), die Aminosäuren wurden mit Azetonninhydrin (0,2 %ig) entwickelt und mit Kupfernitrat fixiert.

Versuchsergebnisse

In 1966, im Jahre der Colchicinbehandlung kamen in den Geweben der langsam sich entwickelnden Pflanzen diploide und in verschiedenem Grade polyploide Zellen nebeneinander vor, d.h. es bestand eine Myxoploidie. 60—70 Prozent der Zellen waren tetraploid. Die myxoploiden Gewebe brachten in den Blättern Missbildungen zustande (Abb. 2. Tafel I). Manche Blätter zeigten Riesenwuchs mit Blattlamellenlängen von nicht selten 15 cm. Die Reifung der erstgebundenen Früchte war um 3—4 Wochen verzögert. Um das Reifen der Früchte zu sichern, wurden wegen des kalten Wetters die Pflanzen ausgegraben und in Kulturgefässen ins Triebhaus gebracht. Da uns die Tetraploide interessierten, wurden einzelne Samen der Schoten (5—8) zum Keimen gebracht und dann Chromosomenzählungen vorgenommen. (Abb. 5, und 6, Tafel II). stellen die Chromosomensätze der tetraploiden Fruchtkerne — ohne Vorbehandlung — dar. Die Chromosomen sind lang, gekrümmt und sehr schwer zu zählen. An Abb. 1, und 2, von Tafel II sind die Chromosomen der Diploiden (2n = 24) — vorbehandelten — Früchte zu sehen, und zwar schon die gedrungenen, geradegereckten Formen. Ein ebenfalls vorbehandeltes Präparat zeigt auch Abb 3 und 4 an Tafel II, hier liegen tetraploide (2n = 48) Zellen von. Da wir die Samen der behandelten Pflanzen zum Keimen gebracht hatten, waren die ausgesprossenen Keimpflänzchen schon nicht die behandelte Generation, sondern Genus C_1, so dass die 1967 gezüchteten Pflanzen als vererbte Tetraploide zu betrachten sind. Die Vererbung der Polyploidie beweist auch der Umstand, dass wir Kerne aus den Früchten der 1967 gezüchteten Pflanzen keimen liessen und sich auch die Generation C_2 als tetraploid erwies.

Hinsichtlich des Chromosomenbestandes des Capsicum-Genus ist zu bemerken, dass Darlington (1957) bei der ganzen Solanaceae-Familie 2n = 24 beschrieb. Cooper und Rieman (1958) stellten fest, dass die gesamten gezüchteten Kartoffeln tetraploid (2n = 48) sind, unter den Artenhibriden aber auch diploide Pflanzen vorkommen. Goodspeed und Thompson (1959) fanden anlässlich ihrer zytotaxonomischen Untersuchungen, dass der Nicotiana-Genus Arten mit dem Chromosomensatz 2n = 24 und 2n = 48 enthält. Darüber hinaus wurde auch eine aneuploide Reihe nachgewiesen. Nach Pandey (1960) sind viele Forscher zu dem Schluss gekommen, die Grund-Chromosomenziffer der Solanaceae-Familie betrage 2n = 12. Smith (1957) dagegen wies nach, dass bei allen Arten des Capsicum-Genus der diploide Chromosomensatz 2n = 24 beträgt. Wir betrachten als diploid Chromosomenbestände von 2n = 24.

Auch die Form der Flanzen des 1967 gezüchteten, tetraploiden Genus C_1 unterschied sich stark von der der diploiden Kontrollen. Die tetraploiden Pflanzen waren bereits zur Zeit der vollen Blüte um 15—20 cm höher gewachsen als die diploiden, beim Eintritt der Reife aber glich sich diese Differenz aus. In den Entwicklungsphasen der tetraploiden Pflanzen war schon kein Zurückbleiben hinter den diploiden mehr zu verzeichnen wie im Jahre der Behandlung. Beide Vairanten blühten zur gleichen Zeit, die Blüten der tetraploiden Pflanzen waren in der

Regel grösser als die der diploiden. Abb. 1, an Tafel I zeigt zwei grosse Blüten in natürlicher Grösse. Das Kelchblatt der einen Blüte ist 16-teilig, der Durchmesser der einen Blume beträgt bei Aufsicht 4,0 cm, der der anderen 3,8 cm. Im Jahre der Colchicinbehandlung wich der Habitus der Pflanzen stark von dem der unbehandelten diploiden ab, doch entbehrten die Abweichungen der Eineitlichkeit. Die tetraploiden Nachkommen C_1 zeigten schon einheitlich entwickelte Gestalt, so dass wir 1967 auch morphologische Untersuchungen anstellten.

Die makroskopisch augenfälligste Abweichung an den Stengeln war der Grössenunterschied zwischen di- und tetraploiden Individuen: der tetraploide Stengel ist fast zweimal so dick wie der diploide, dennoch ist hinsichtlich Zahl und Zeichnung der an den Stengeln sichtbaren Carinen und Vallekulen kein wesentlicher Unterschied zu beobachten. Das Beteiligungsverhältnis der einzelnen Gewebsarten im Querschnitt der beiden Stengel führt Tabelle I. vor Augen.

Tabelle I. Prozentuelles Beteiligungsverhältnis der Gewebe diploider und tetraploider Paprikapflanzen im Stengelquerschnitt.

Gewebe	Diploid	Tetraploid
Epidermis + Rindenparenchym	22,8	25,7
Collenchyma	8,2	7,0
Phloemgewebe + Kambium	6,9	7,3
Xylem	28,6	44,5
Markstrahlparenchym	33,5	15,5

Der Tabelle ist zu entnehmen, dass die grösste Abweichung zwischen den beiden Arten das Xylem und das Parenchym der Marksubstanz aufweisen. Im Stengel der tetraploiden Variante ist das Xylem annährend um 30 % grösser. Dieser entwickeltere Holzanteil ist natürlich zur Sicherung eines weit besseren und schnelleren Wasser- und Nährstofftransportes imstande als der kleinere Holzanteil bei den diploiden Pflanzen.

Auffallend ist, dass im Stengel der tetraploiden Paprikapflanzen das Markgewebe sehr spärlich entwickelt war (15,5 %). Von allen Geweben ist bei den tetraploiden Pflanzen das Xylem mit 44,5 % Beteiligung das bestentwickelte (s. Tabelle I, und Abb. 3, und 4, an Tafel I), während in den diploiden Stengeln das Markgewebe (mit 33,5 %) dominiert und erst dann das Xylem usw. folgen. Der gewaltige Grössenunterschied im Holzanteil der tetra- und der diploiden Sorte geht auch daraus hervor, dass im Falle der diploiden Variante die Vergrösserung des ganzen Xylem auf der Abbildung Platz hatte, im Falle der tetraploiden aber — bei gleicher Vergrösserung — nur ein Teil davon. In den beiden Stengeln ist hinsichtlich der in Tabelle I. angeführten übrigen Gewebe die Abweichung eine minimale — 1-3 % — (Abb. 3, und 4, in Tafel III) — Beim Vergleich der Gewebebeteiligung im Holz- und Markanteil der beiden Stengelarten ist ein reziprokes Verhältnis zu beobachten. Dies

deutet darauf hin, dass betreffs der Entwicklung von Holz- und Markgeweben ein weit engerer Zusammenhang besteht zwischen dem Holz- und den übrigen Gewebetypen. Es ist wahrscheinlich, dass im Falle der tetraploiden Pflanzen das Xylem schon im jungen Alter auf Kosten des Markanteiles gewachsen ist. Ein weiterer grundlegender Unterschied zwischen den beiden Stengeln ist noch, dass fast alle Gewebebestände der tetraploiden Variante aus grösseren Zellen aufgebaut sind. Am deutlichsten tritt dies im Parenchym des Markgewebes zutage (Abb. 5, und 6, in Tafel III). Auf eine Gebietseinheit entfallen also im diploiden Stengel stets mehr Zellen.

Erhebliche Unterschide zwischen di- und tetraploiden Varianten machen sich auch im morphologischen und strukturellen Gefüge des Blattstieles bemerkbar. Bei der tetraploiden Art ist der Blattstiel kurz, dick und auch sein Gefässbündel besser entwickelt; am auffallendsten aber ist sein gewaltiges Phyllodium (Abb. 5, Tafel IV), welches auch die Assimilationsfläche bedeutend vergrössert. Bei den diploiden Individuen ist zwar der Ansatz eines Phyllodium ebenfalls vorhanden, und auch ein Assimilationsparenchym ist darin zu beobachten, doch ist dieses im Vergleich zu dem vorgenannten unbedeutend (Abb. 6, Tafel IV).

Beim Vergleich der Blätter dienten die Dicke der Blattlamellen, der Entwicklungsgrad der Äderung, die Zahl der auf eine Gebietseinheit entfallenden Epidermiszellen sowie die Zahl der Stomen als Grundlage. Die Auswertung der Blattepidermis ist noch im Gange und daher betreffs der Blätter ist vorerst nur folgendes festzustellen: Die Blätter der tetraploiden Flanzen sind breiter, haben eine grössere Oberfläche und typische Herzschulterform. Ihre Äderung erinnert an die der diploiden, doch fällt sofort die hochentwickelte Hauptader auf (Abb. 3, und 4, an Tafel IV), diploiden Blätter. Die Blattlamelle ist interessanterweise dicker als bei

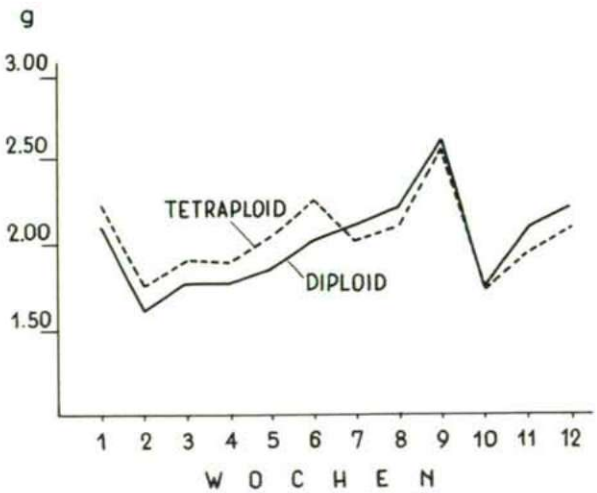

Diagramm 1.: Trockensubstanz aus je 10 g frischen diploiden und tetraploiden Paprikablättern. Wöchentlich entnommene Proben (1—12).

diploiden Blätter. Die Blatlamelle ist interessanterweise dicker als bei den diploiden Blättern (Abb. 1, und 2, Tafel IV). Diese Tatsache ist auf das besser entwickelte, spongiöse Parenchym der diploiden Blätter zurückzuführen. Hinsichtlich des Palisadparenchyms waren wesentliche Abweichungen nicht festzustellen. Im Mesophyllum war noch zu beobachten, dass die diploiden Blätter weitaus mehr Idioblasten enthalten.

Im Jahre der Colchicinbehandlung wurde aus 10 g Frischmaterial im Falle der tetraploiden Blätter bei jeder Untersuchung weniger Trockensubstanz erhalten, als bei den diploiden. Der Wassergehalt der tetraploiden war in jeder Phase der Entwicklung um 10—15 % grösser als bei den diploiden. Beim Genus C_1 erfuhr diese Richtung 1967 eine Wandlung. Aus dem Graphikon Nr. 1 ist ersichtlich, dass aus 10 g frischer Substanz anlässlich der ersten sechs Untersuchungen in jedem Falle das tetraploide Material mehr Trockensubstanz lieferte. Wenn auch bei den folgenden sechs Untersuchungen viermal die Trockensubstanzmenge bei der diploiden Sorte grösser war, gleicht dies doch den Vorteil der tetpraploiden Variante nicht aus, denn in der neunten und zehnten Woche lieferten beide Sorten annähernd gleiche Werte.

Die quantitativen Messungen der löslichen Gesamtproteine im Falle des Genus C_1 ergaben, dass die tetraploide Sorte — ebenso wie beim Trockenmaterial — auch hier in sechs Fällen die diploide übertraf (Abb. 2) und nur anlässlich dreier Untersuchungen geringere Werte lieferte als die diploide.

Vergleich der Diagramme 1, und 2 lässt einen Zusammenhang in der Richtungsänderung des Kurvenverlaufes feststellen. Ausserdem stimmen auch die Wertänderungen betreffs des löslichen Gesamproteins und der Trockensubstanz bei di- und tetraploiden Varianten ziemlich überein.

Die Farbe der tetraploiden Blätter unterschied sich sowohl im Jahre der Behandlung, als auch in dem folgenden Jahr von der der diploiden: sie waren von satterem, etwas bläulichem Grün. Bei der dünnschicht-

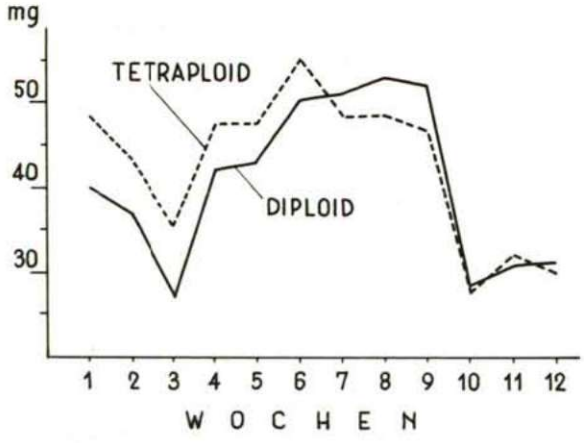

Diagramm 2.: Lösliches Gesamtprotein der Blätter diploider und tetraploider Paprikapflanzen, mg/1 g frisches Material. Wöchentlich entnommene Proben.

chromatographischen Untersuchung der Farbstoffelemente der Chloroplasten der beiden Sorten stellte sich heraus, dass das quantitative Verhältnis der einzelnen Farbstoffe in den beiden Varianten vollkommen identisch war. Auch die Gesamtchlorophyllmessungen zeigten — auf 1 g frische Substanz bezogen — keine Abweichung zwischen di- und tetraploiden Blättern. Die mikroskopischen Untersuchungen ergaben dann, dass die Farbabweichungen zwischen di- und tetraploiden Blättern dadurch bedingt waren, dass die Chloroplasten der tetraploiden Blätter grösser waren und auch ihre räumliche Verteilung eine andere ist.

Im Jahre der Colchicinbehandlung zeigten die Aminosäureuntersuchungen in keinem einzigen Falle eine qualitative Abweichung zwischen diploiden und tetraploiden Varianten. Demgegenüber war der Gesamtaminosäuregehalt der Blätter der tetraploiden Paprikapflanzen höher als der der diploiden. Dies deutete auf die infolge der Colchicinbehandlung eingetretene Störung in der Eiweißsynthese hin.

Die qualitative Zusammensetzung der Aminosäuren des tetraploiden Genus C_1 unterscheidet sich nicht von der bei den diploiden Individuen, während der Gesamtaminosäurengehalt in der 4. und 5. Woche in den Blättern der diploiden Paprikapflanzen höhere Konzentrationen erreichte. Hier betrug der Gesamtaminosäurengehalt pro 1 g Trockensubstanz in den diploiden Blättern 9,5 mg (4. Woche) und 7,5 mg (5. Woche) und in den tetraploiden 7,0 mg (4. Woche) und 6,5 mg (5. Woche). Die zweidimensionalen Schuchtchromatogramme der in der vierten Woche entnommenen Blätterproben zeigen an Abb. 1, und 2, von Tafel III. die Zusammensetzung der Aminosäuren bei diploiden und tetraploiden Paprikapflanzen, sie liefern gewissermassen auch Aufschluss über die quantitativen Verhältnisse und zeigen ferner, dass beim Paprika Alanin, Glutaminsäure und γ-Aminobuttersäure den grössten Fleck geben. Bei den einzelnen Untersuchungen wurden aber die grössten Veränderungen in quantitativer Hinsicht im Falle der γ-Aminobuttersäure gefunden.

Die quantitativen und qualitativen Auswertungen der Früchte des Genus C_1 wurden im Herbst 1967 nicht durchgeführt. Die infolge der Colchicinbehandlung entstandenen Schädigungen waren von diesem Genus noch nicht überwunden, die Früchte waren noch sichtlich minderwertig. Die Keimungsproben der Samen des Genus C_1 aber liessen bereits eine grosse Besserung im Verhältnis zu den Früchten des Vorjahres feststellen. Gegenüber dem Keimungsvermögen der im Jahre der Behandlung erzeugten Samen von 50 % betrug das der Samen des Genus C_1 schon 80—90 Prozent. Allerdings waren die Samen der tetraploiden Pflanzen rund doppelt so gross wie die der diploiden, doch betrug die Zahl der in einer Frucht enthaltenen Samen um 40—50 Prozent weniger als in den diploiden Schoten. Es wurden einige grössere und qualitativ bessere Schoten tragende Pflanzen ausgewählt, um ihre Nachkommen in den folgenden Jahren gesondert zur Vermehrung zu bringen. Die Samen des tetraploiden Genus C_1 wurden zum Keimen angesetzt un Chromosomenzählungen aus dem Meristem der Würzelchen (Genus C_2) vorgenommen. Den Ergebnissen zufolge ist diese Sorte vererblich tetraploid.

Besprechung der Ergebnisse

Im Jahre 1966 haben wir mittels Colchicinbehandlung polyploide Paprikapflanzen gezüchtet. Die Samen der Schoten wurden im Herbst zum Keimen gebracht und aus dem Meristem der Würzelchen Chromosomenzählungen vorgenommen. Etwa 70 % der früchtetragenden Pflanzen waren tetraploid (2n = 48). Die höher polyploiden Varianten gingen innerhalb des Kulturjahres zugrunde. Da im Jahre der Behandlung die Gewebe der einzelnen Pflanzen di-, tetra- und polyploide Zellen nebeneinander enthielten (myxoploides Gewebe), kam es wegen der verschieden grossen Zellen in den einzelnen Organen zu Missbildungen verschiedenen Grades. Die Mehrzahl der Gewebezellen aber stellte tetraploide Elemente dar (60—70 %), und auch die meisten Früchte erwiesen sich als tetraploid. Im Jahre der Behandlung zeigten die einzelnen Pflanzen stark heterogenen Habitus, deshalb wurde von der Durchführung histologischer Untersuchungen Abstand genommen.

Laut den physiologischen Untersuchungen ist der Wassergehalt der behandelten Pflanzen während der ganzen Evolutionsperiode um 10—15 % höher als bei den diploiden Kontrollen.

Tretjak und Okanenko (1966) fanden bei polyploiden Zuckerrüben ebenfalls eine grössere Wassersättigung des Protoplasmas als bei diploiden Pflanzen. Dies ist unseres Erachtens eine Folge der Vermehrung des schwach gebundenen Wassers. Die Autoren kamen zu der Schlussfolgerung, dass der Gehalt an festgebundenen Wasser mit zunehmender Polyploidie nachlässt. Dessenungeachtet pflegt das Wasserdefizit der polyploiden Pflanzen in den heissen Mittagsstunden etwas geringer zu sein als das der diploiden.

Qualitativ war die Zusammensetzung der Aminosäuren im Jahre der Colchicinbehandlung bei beiden Pflanzensorten vollkommen gleich, quantitativ aber war der Aminosäurengehalt der behandelten Pflanzen während der ganzen Kulturperiode um 15—20 % höher als im Falle der diploiden, was auf eine Störung in der Eiweißsynthese der myxoploiden Gewebe hinweist.

Auch Wolter (1965) wies bei tetraploiden Zuckerrüben einen höheren Aminosäurengehalt nach als bei diploiden. Laut seinen Angaben sind in den tetraploiden Varianten in grosser Menge auch Aminosäuren anzutreffen, die in der diploiden Variante nur in geringer Quantität oder überhaupt nicht vorkommen. Wir haben derartige Abweichungen beim Paprika nicht gefunden.

Im Jahre der Colchicinbehandlung wurden stark unterentwickelte Früchte erhalten und auch die Reifezeit war um 3—4 Wochen verzögert. Die Zahl der Kerne in den einzelnen Schoten betrug nur 10—20 und auch ihre Keimfähigkeit erreichte höchstens 50 %. Im Jahre 1967 wurden nur die sicher tetraploiden Individuen weitergezüchtet.

Die bereits vererbt tetraploiden Paprikapflanzen taten sich durch ein allgemein intensiveres Wachstum hervor, sie waren grösser und schwerer als die diploide Ausgangssorte (Kontrollen). Blütenstand und Fruchtreife fielen zeitlich bei dem tetraploiden Genus C_1 und den diploiden Pflanzen zusammen.

Der Stengel der in ihren Habitus schon einheitlich tetraploiden C_1-Pflanzen ist fast doppelt so dick wie der der diploiden. Diese Verdickung ist nicht nur durch die Vergrösserung der das Gewebe bildenden Zellen bedingt, sondern teilweise auch Folge des Wachstums der Transportelemente, welches einen gesteigerten Stoffwechsel ermöglicht. Auch Tretjak und Okanenko (1966) fanden bei Zuckerrüben mit zunehmendem Ploidiegrade eine Vergrösserung des Durchmessers der Xylemgefässe. In den Stengeln unserer tetraploiden Paprikapflanzen wurde der Durchmesser der Xylemgefässe ebenfalss grösser, bedeutsamer aber ist die grössere Ausdehnung des ganzen Holzanteilquerschnittes überhaupt. Horváth (1965) fand anlässlich seiner ökologischen Untersuchungen im Stengel von Erbsen ebenfalls eine Vergrösserung des Xylems auf Kosten des Markparenchyms.

Bei den tetraploiden Pflanzen ist wegen der Vergrösserung der Blattfläche, des Stengelumfanges und des am Blattstiel breit entwickelten Phyllodiums die Assimilationsfläche erheblich vergrössert.

Obzwar die Blätter der tetraploiden Variante C_1 sich mit ihrem satten grün stark von der Farbe der diploiden unterscheiden, konnten im Laufe der Untersuchungen doch weder im Gesamtchlorophyllgehalt, noch in den Chloroplastkomponenten Abweichungen festgestellt werden. Die mikroskopischen Befunde ergaben, dass der Farbunterschied durch die unterschiedliche räumliche Anordnung der grösseren Chloroplasten in den tetraploiden Blättern — gegenüber der bei den diploiden Pflanzen beobachteten — verursacht war. Essad und Touvin (1959) fanden ebenfalls, dass in den Blättern der polyploiden Rüben die Chloroplasten vergrössert waren und im mikroskopischen Gesichtsfeld in geringerer Zahl vorhanden waren als in den diploiden Blättern. Die Autoren schlugen diese Tatsache als eine Methode zur schnellen Auswahl der Polyploide vor mit der Bemerkung, dass sichere Daten durch die Chromosomenzählung zu erhalten sind.

Hinsichtlich des aus 10 g frischen Blättern gewonnenen Trockengewichtes erwies sich die tetraploide Variante als vorteilhafter. Diese Tatsache lässt mit einer schnellen Besserung der tetraploiden Paprikapflanzen in den nächsten Generationen rechnen, war doch im Vorjahre während der ganzen Züchtungsperiode der Trockensubstanzgehalt der Blätter der diploiden Pflanzen grösser.

Die Menge des löslichen Gesamtproteins in den tetraploiden Blättern erwies sich im allgemeinen ebenfalls als grösser als die der diploiden Pflanzen. Zu ähnlichen Ergebnissen kamen auch Shimano und Mitarbeiter (1959) sowie Takasugi und Mitarbeiter (1959) in Verbindung mit den Blättern von polyploiden *Vicia angustifolia* L., bzw. *Astragalus sinicus* L.

Beim Vergleich des Gesamptproteingehaltes (Abb. 2) und der Trockengewichtskurven (Abb. 1) ist festzustellen, dass parallel mit dem Zu- bzw. Abnehmen des Gesamtproteingehaltes auch die Trockengewichtskurve steigt oder sinkt. Ausserdem wechseln auch die quantitativen Verhältnisse der beiden Varianten an den Kurven der beiden Abbildungen parallel. Hieraus ist ersichtlicht, dass zwischen dem Gehalt

an löslichem Gesamtprotein und der Vermehrung des Trockensubstanzgehaltes ein enger Zusammenhang besteht.

Das Aminosäurenspektrum des tetraploiden Genus$_1$ ist vollkommen identisch mit der Zusammensetzung der Aminosäuren in den diploiden Blättern. In zwei Fällen war die Gesamtaminosäurenkonzentration der diploiden Variante grösser als die der tetraploiden. Allerdings herrschte zur Zeit der Untersuchungen heisses Wetter, was eine Störung in der Eiweißsynthese verursacht haben dürfte. Die tetraploide Variante vermochte die grosse Hitze leichter zu tolerieren, da ja ihre aktiven wassertransportierenden Gewebe, d.h. das Xylem, gegenüber denen der diploiden Pflanzen riesig vergrössert war.

Im Jahre 1967. wurden die vererbten Tetraploide durch künstliche Bestäubung mit dem Ausgangsdiploid rückgekreuzt und daraus auch Früchte erhalten, allerdings mit stark verminderter Samenzahl. Die Untersuchung dieser Chromosomen ist eine unserer nächsten Aufgaben. Eine optimale Vitalität zeigen nach den Befunden von Knapp (1957), Lebedeva (1959) und Müntzing (1956) die Triploide.

Bei den tetraploiden Pflanzen kommt es häufig zu Mutationen, wodurch Auswahl neuer, besserer Stämme möglich wird. Eine bedeutende — wenn auch nicht vorteilhafte — Mutation fanden wir bereits: Die Ausgangssorte für die Colchicinbehanglung war eine konstant vererbliche, capsaicinfreie Paprikasorte, und dennoch enthielten rund 20 % der Früchte des tetraploiden Genus C_1 Capsaicin. Da diese Mutation bei sämtlichen Früchten einiger Pflanzen in Erscheinung trat, ist eine Selektierung unschwer möglich.

Zusammenfassung

Die Verfasser haben an einem selbstgezüchteten tetraploiden Paprikapflanzenbestand (*Capsicum annuum* L.) morphologische, histologische und physiologische Untersuchungen angestellt.

1. Im Jahre der Colchicinbehandlung (C_1 Genus) wurden myxoploide Blätter erhalten, deren Form infolge von Gewebsverschiebungen Missbildungen aufwies. Die über höhere Genome verfügenden Pflanzen gingen zugrunde. 70 % der fruchttragenden Individuen wurden tetraploid. In den einzelnen tetraploiden Früchten ging die Zahl der Kerne auf 10—20 zurück, und auch deren Keimungsfähigkeit war nur eine 50-prozentige.

2. Der Trockensubstanzgehalt der Blätter der mit Colchicin behandelten Pflanzen war um 10—15 % geringer als der in der diploiden Variante, d.h. der Wassergehalt in den Blättern der myxoploiden Pflanzen war höher als der in den unbehandelten diploiden.

3. Der Gehalt der myxoploiden Blätter an freien Gesamtaminosäuren war während der ganzen Untersuchungsperiode grösser als bei den diploiden Pflanzen. Diese Vermehrung war eine Folge der Eiweißsynthesestörung bei der colchicinbehandelten Variante. Qualitative Unterschiede betreffs der Aminosäuren bestanden nicht.

4. Die erblich tetraploiden Paprikapflanzen (Genus C_1) gediehen schneller als die diploiden und dieser Unterschied wurde erst zur Zeit

der Fruchtreife ausgeglichen. Die Entwicklungsphasen der tetra- und diploiden Varianten fielen zeitlich zusammen. Die Zahl der Samen in den tetraploiden Schoten blieb immer noch hinter der in den diploiden zurück, wogegen die Keimungsfähigkeit der Samen auf 80—30 % stieg.

5. In den Stengel- und Blattquerschnitten der tetraploiden Sorte (C_1) sind Transportelemente in wesentlich grösserer Zahl vorhanden als in der diploiden, was einen intensiveren Materialtransport ermöglicht. In den tetraploiden Stengeln ist das Xylem auf Kosten des Markparenchyms um rund 30 % vermehrt.

6. In den tetraploiden Individuen ist infolge der Vergrösserung der Blattfläche und des Stengelumfanges, sowie der gutentwickelten Phyllodien die Assimilationsfläche erheblich grösser geworden.

7. Da in den tetraploiden Geweben die Zellen umfangreicher sind als in den diploiden, ist hier die Zahl der auf eine Gebietseinheit entfallenden Zellen geringer als im diploiden Gewebe.

8. Hinsichtlich der aus gleich schweren Mengen Frischmaterial erhaltenen Trockensubstanzgewichte erwies sich das tetraploide Genus C_1 als vorteilhafter als die Kontrollen, was zur Hoffnung auf eine schnelle Besserung der Sorte in den folgenden Jahren berechtigt, da ja im Vorjahre die Trockensubstanz der diploiden Variante noch die grössere war. Auch der Gehalt an löslichen Gesamtproteinen ist in den tetraploiden Blättern gewöhnlich ein höherer als in denen der diploiden Ausgangssorte.

9. Die qualitative Zusammensetzung der Aminosäuren in dem tetraploiden Genus C_1 stimmt völlig mit der in den diploiden Blättern überein. Die Gesamtaminosäurenkonzentration in den Blättern der beiden Varianten zeigte im Laufe der 12 Untersuchungen keine nennenswerten Abweichungen.

10. Die tetraploiden Blätter sind von einem satteren Grün als die diploiden. Diese Abweichung ist weder durch die qualitative Zusammensetzung der Farbstoffkomponenten in den Chloroplasten, noch durch die quantitativen Unterschiede im Gesamtchlorophyllgehalt bedingt. In den Zellen der tetraploiden Blätter sind die Chloroplasten grösser und räumlich anders angeordnet als in den diploiden, daher die farbliche Abweichung.

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Tafel I. *Abb. 1.:* Riesenblüten einer tetraploiden Paprikapflanze (Genus C_1), natürliche Grösse.
Abb. 2.: Myxoploide Zellen enthaltende, missgebildete Paprikablätter.
Abb. 3.: Innenanteil des Stengelquerschnittes einer tetraploiden Paprikapflanze. Zentraler Teil des Xylem. x150.
Abb. 4.: Teil des Stengelquerschnittes einer diploiden Paprikapflanze mit Xylem. x 150.

Tafel II. *Abb. 1. und 2.:* Diploide (2 n = 24) Wurzelmeristemzellen in der Metaphase. Vitale Vorbehandlung bewirkte Verkürzung der Chromosomen. x 1250 + Photo x 5.
Abb. 3. und 4.: Tetraploide (2n = 48) Wurzelmeristemzellen im der Metaphase, mit vitaler Vorbehandlung (C_1 Genus). x 1250 + Photo x 5.
Abb. 5. und 6.: Polyploide Wurzelmeristomzellen in der Pro- und Metaphase (C Genus), (Jahr der Behandlung). Ohne vitale Vorbehandlung sind die Chromosomen lang und gekrümmt. x 1250 + Photo x 5.

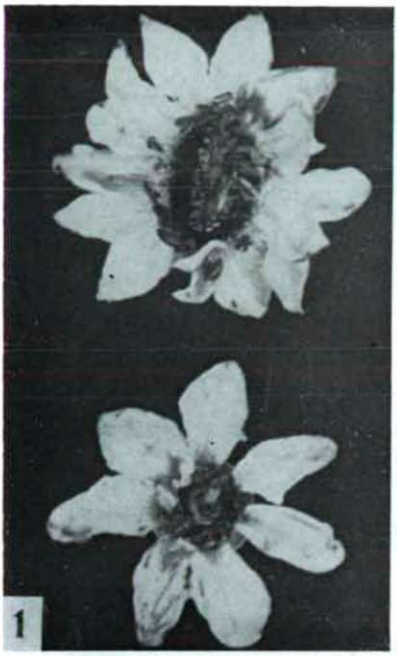
Tafel III. *Abb. 1.:* Dünnschichtchromatogramm der Aminosäuren in tetraploiden Paprikapflanzenblättern:

1 = Leu	6 = Ala	11 = Asp
2 = Phe	7 = Thr	12 = Glu-NH_2
3 = Val, Met	8 = Glu	13 = Asp-NH_2
4 = γ-Amb	9 = Gly	14 = Lys
5 = Pro	10 = Ser	15 = Cys

Abb. 2.: Dünnschichtchromatogramm der Aminosäuren in diploiden Paprikapflanzenblättern.
Bezifferung gleichbedeutend mit der in Abbildung 1 bzgl. der tetraploiden Variante.
Abb. 3.: Äusserer Teil des Stengelquerschnittes einer tetraploiden Paprikapflanze (C_1-Genus). Unten im Bilde äusserer Xylemanteil. x 80.
Abb. 4.: Äusserer Teil des Stengelquerschnittes einer diploiden Paprikapflanze. Unten im Bilde innerer Xylemanteil. x 80.
Abb. 5.: Mark-Parenchym eines tetraploiden Stengels. x 200.
Abb. 5.: Mark-Parenchym eines diploiden Stengels. x 200.

Tafel IV. *Abb. 1.:* Querschnitt eines tetraploiden Blattes. x 200.
Abb. 2.: Querschnitt eines diploiden Blattes. x 200.
Abb. 3.: Querschnitt einer tetraploiden Blattader. x 80.
Abb. 4.: Querschnitt einer diploiden Blattader. x 80.
Abb. 5.: Querschnitt des Phyllodiums eines tetraploiden Blattstieles. x 80.
Abb. 6.: Teil des Querschnittes eines diploiden Blattstieles mit dem Phyllodium. x 80.

TAFEL I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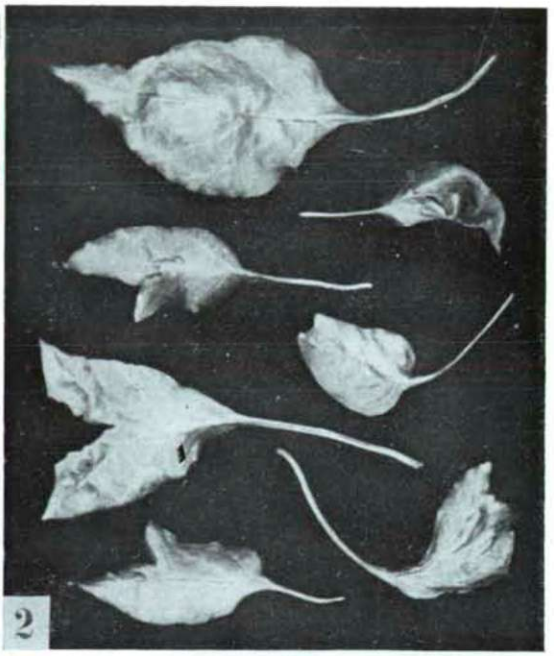
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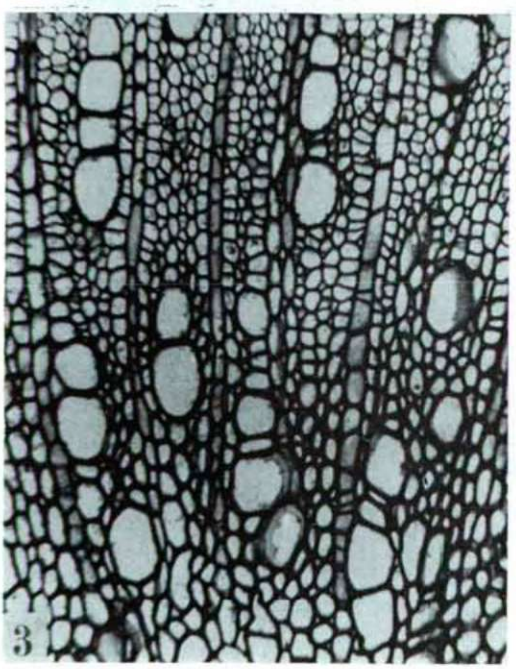
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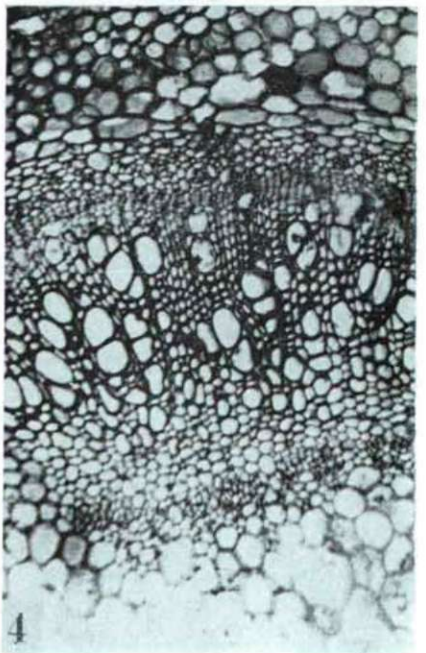
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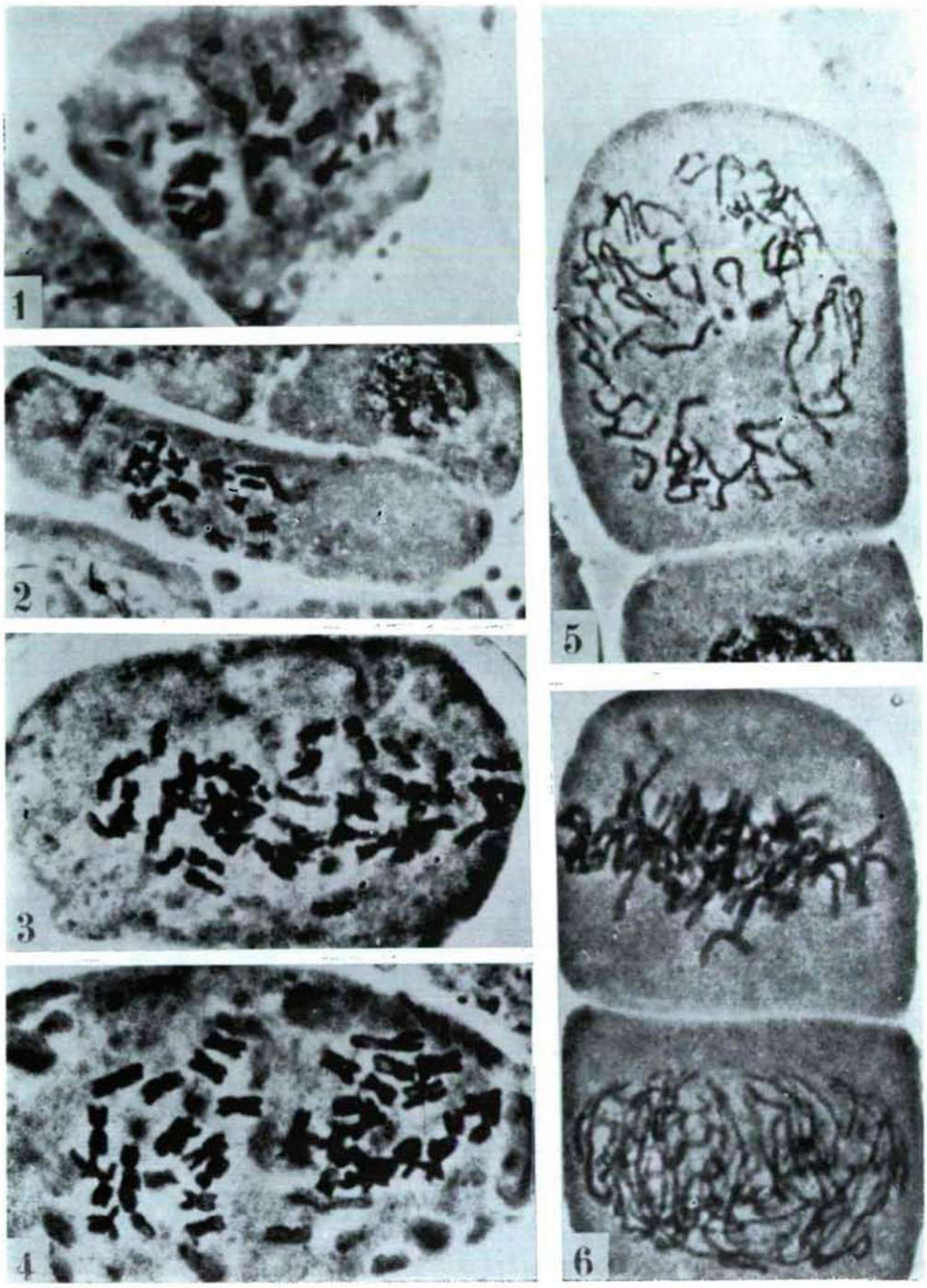

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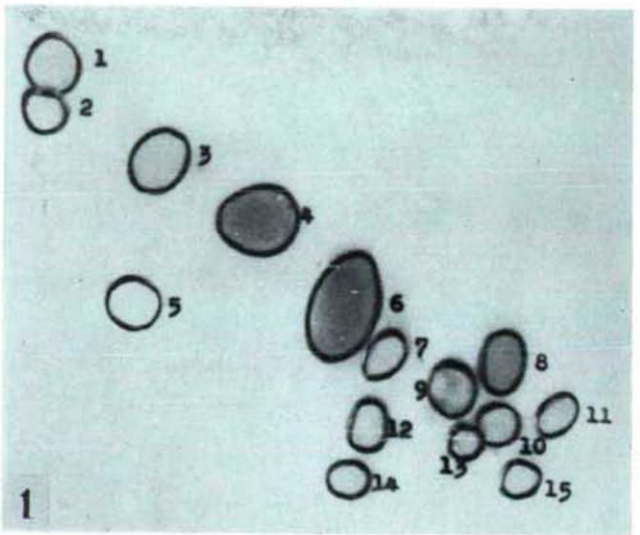

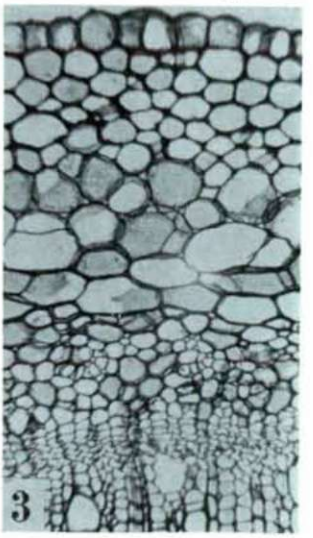

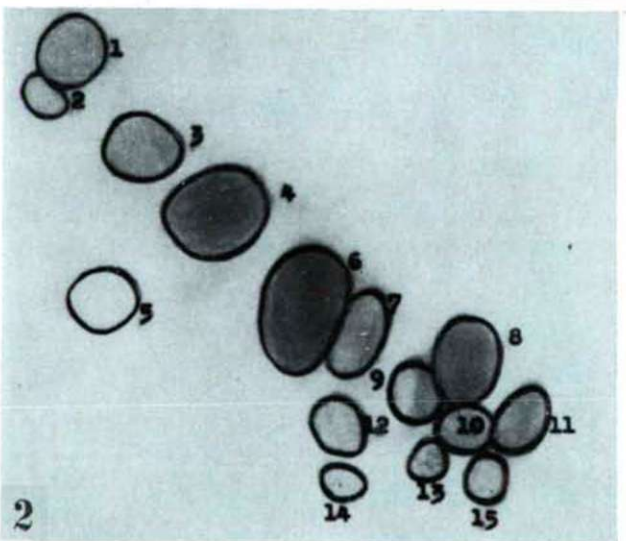

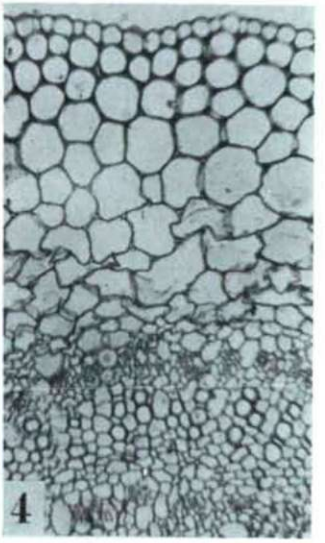

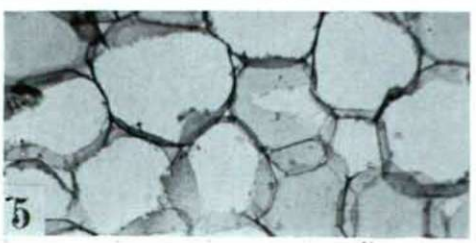

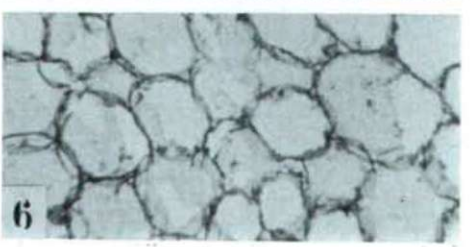

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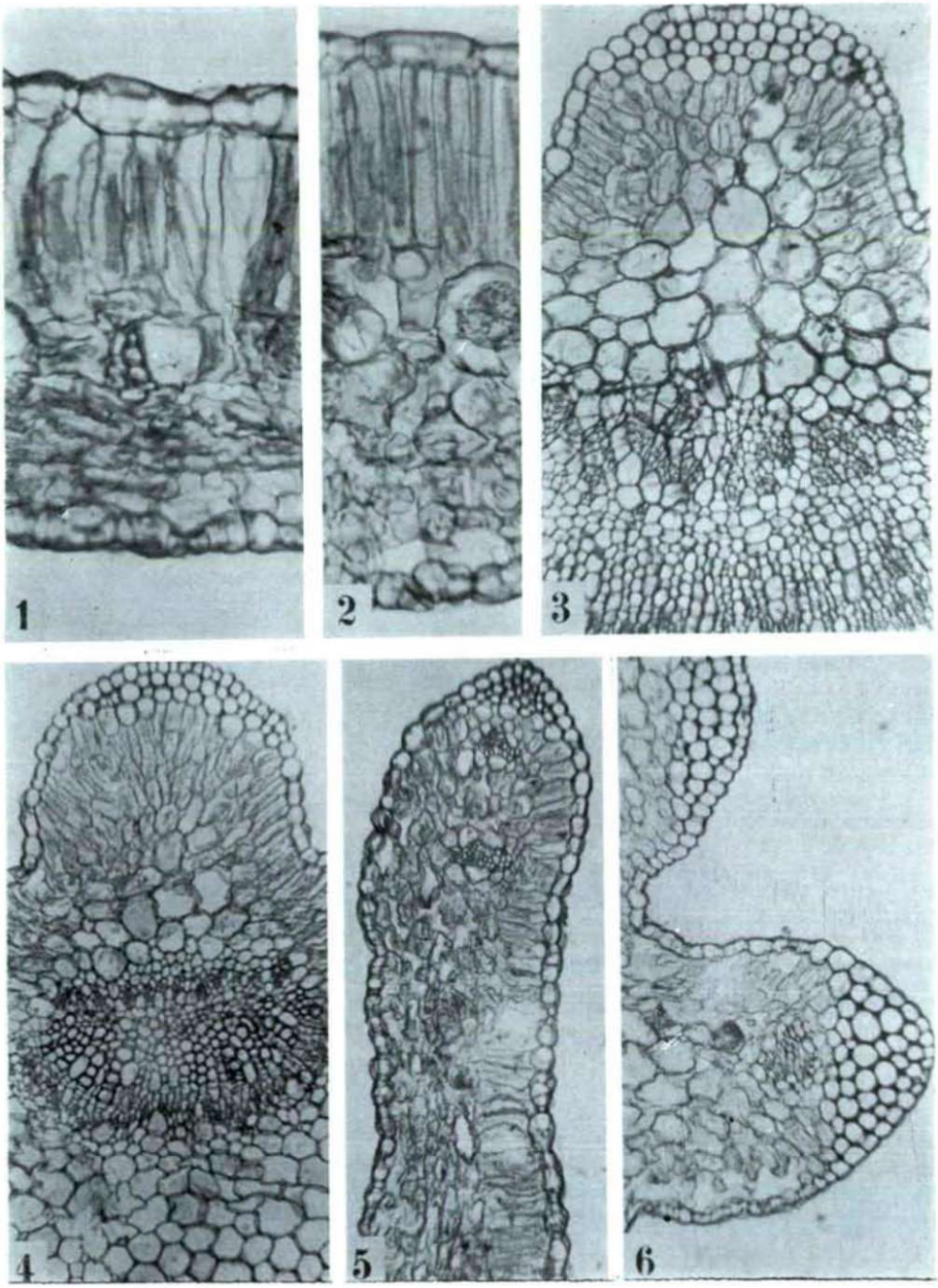

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RELATIONSHIP BETWEEN THE PLANT GROWTH REGULATION AND PHOSPHORYLATION PROCESSES I. EXAMINATION OF THE ALCOHOL SOLUBLE PHOSPHATE COMPOUNDS OF PEA SEEDLINGS BY RADIOPAPER-CHROMATOGRAPHY, APPLYING DIFFERENT LIGHT CONDITIONS AND DIFFERENT INCUBATION TIMES

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Introduction

In studying the effect of plant growth regulators the examination of the relationship between growth and oxidative phosphorylation processes is very significant.

It is known that the most plant regulators are also active as regulators of the oxidative phosphorylation. Many authors believe the basic reaction of the effect of plant hormones and of other regulators begins by the influence of phosphorylation reactions (Marinos and Hemberg, 1960; Sen-Gupta and Sen, 1961; Flaig and Schmid, 1962; Mc Daniel and Sarkissian, 1966).

According to the fact that the satisfaction of the energy requirement is most important for the growth the view of the above mentioned authors can be real, but the results of other authors (Stenlid and Saddik, 1962; Spring and Rowan, 1966) don't allow the generalisation of this rule.

For the determination of the oxidative phosphorylation there is an in vitro laboratory method by the measurement of the P/O quotient. The open question is whether the „in vivo" processes are similar to the results of in vitro measurement or not; the question is therefore whether changing the P/O quotient by plant regulators is the same in the plant tissues and in vitro or not.

The difficulty of in vivo experiments is that to study the regulator effects is possible only by indirect methods on the basis of determination of the ratios of the inorganic phosphates and of the high energy phosphate compounds.

The classical analytical methods being less effective for this determination, the authors worked out an in vivo method, to find the suitable

conditions for the experiments. They separated the inorganic phosphates and the different low and high energy phosphate ester compounds by radiopaperchromatography. The amount of them and their ratios was measured by their activities.

In the first step the seedlings were kept in nutrient solution containing ^{32}P-phosphate. The plants were extracted with ethanol evaporated and paperchromatographied.

The experiments were carried out by seedlings kept in the dark or in the light for 24 hours. From the beginning of the experiments five samples were worked up.

The results showed, how the ^{32}P incorporated into the separated fraction during the incubation and what the correlation was between activity and the light effects.

Experimental Methods and Materials

The seven-ten days old seedlings of *Pisum sativum „Express"* were applied for the experiments. The plants were grown in sand, in greenhouse, at 22—24°C, on sunshine. Before the incubation process the plants were put into a K n o p solution diluted tenfold for two hours. During the experiments they were placed into a K n o p solution containing 15 μC/ml $KH_2{}^{32}PO_4$.

After incubation the reaction was stopped by adding to it hot ethanol and the plants were homogenised and extracted with 70 % ethanol and water for eight hours. The extract was chromatographied in two different solutions; I. n-butanol: n-propanol:acetone:formic acid 80 %:trichloro-acetic acid 30 % 8:4:5:5:3; II. n-butanol:n-propanol:acetone:ammonia 25 %:water 7:3:3:8:1.

The identification of spots was carried out on the basis of their R^f -value, and comparing them with standards, after spraying with different reagents: anilinphtalate, ammoniummolybdenate for sugarphosphates; $HgCl_2$-eozin solution and Wood-reagent for nucleotids; and by autoradiography.

The radioactivity of chromatograms was measured by scaler apparatus with GM-tube, the width of the slit was 0,5 cm. the activity of the following fractions has been decided: 1) inorganic phosphate, 2) ester-phosphate, 3) „indole"-phosphate, 4) nucleotide-phosphate.

The inorganic phosphate compound was ortho-phosphate. The compounds of nucleotid fraction were mainly ADP (adenosine diphosphate) and ATP (adenosine triphosphate). Sugar phosphates, glyceric acid phosphates, and AMP (adenosine monophosphate) belonged to the ester-phosphate fraction. The compounds of the „indole"-phosphate fraction, have given characteristic indole, sugar- and phosphate reactions. The compounds of the nucleotide fraction, have shown characteristic purine, sugar and phosphate reactions and the R^f -values of them were similar to the nucleotide phosphates. On the basis of the examination these compounds have been derivatives of indoleacetic acid.

Experimental Results

1. The Change of the Total ^{32}P activity in the Roots and in the Shoots of Plants According to the Time and Light Conditions

Eight-days old pea seedlings were kept in a K n o p solution diluted tenfold, containing 15 μC/l ^{32}P phosphate at 22 °C in darkness and the other series of pea seedlings were kept in the same condition, and they were illuminated with 4000 lux intensity for 24 hours. During this time the

samples were extracted after 2, 6, 12, 18, 24 hours with ethanol and chromatographied. Fig. 1 shows the total activity concerning one g fresh weight of plant material.

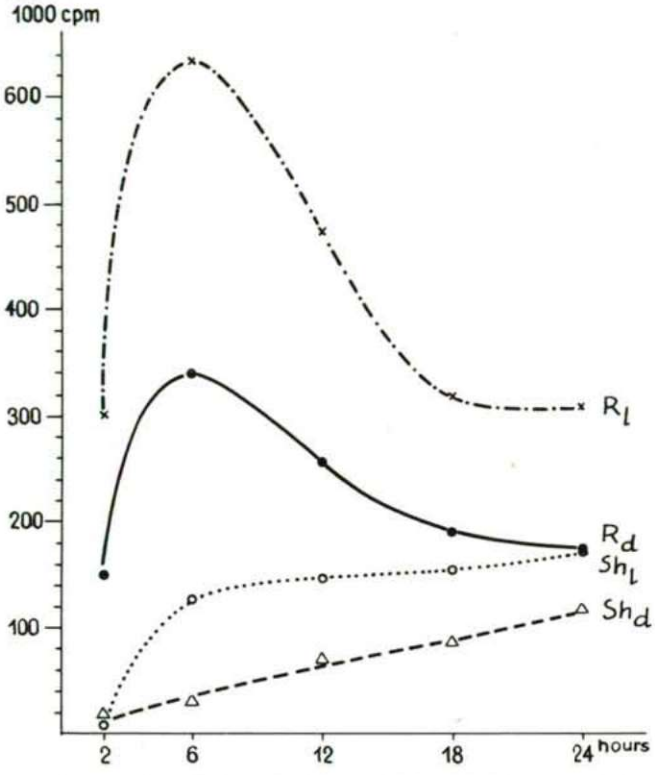

Figure 1. The total activity of the alcohol soluble ^{32}P incorporated into the roots and shoots of pea seedling according to the time and light conditions.
R_l = roots of illuminated seedlings
R_d = roots of seedlings kept in the dark
Sh_l = shoots of illuminated plants
Sh_d = shoots of seedlings kept in the dark

According to the result of experiments the incorporation of ^{32}P during the incubation period was always higher in the roots, than in the shoots. The roots and shoots of illuminated plants showed higher activity than the plants kept in the dark. The maximum of the total activity occurs after 6 hours.

During the time that has been studied the total activity of phosphate compounds of the shoots didn't give a maximum curve. The total activity increased at the beginning of experiments faster than it increased later. The raising of ^{32}P activity in the shoots kept in the dark was continuous. The incorporation of ^{32}P was almost linear. The curves of total activity have not shown significant changes between eighteen and twenty four hours.

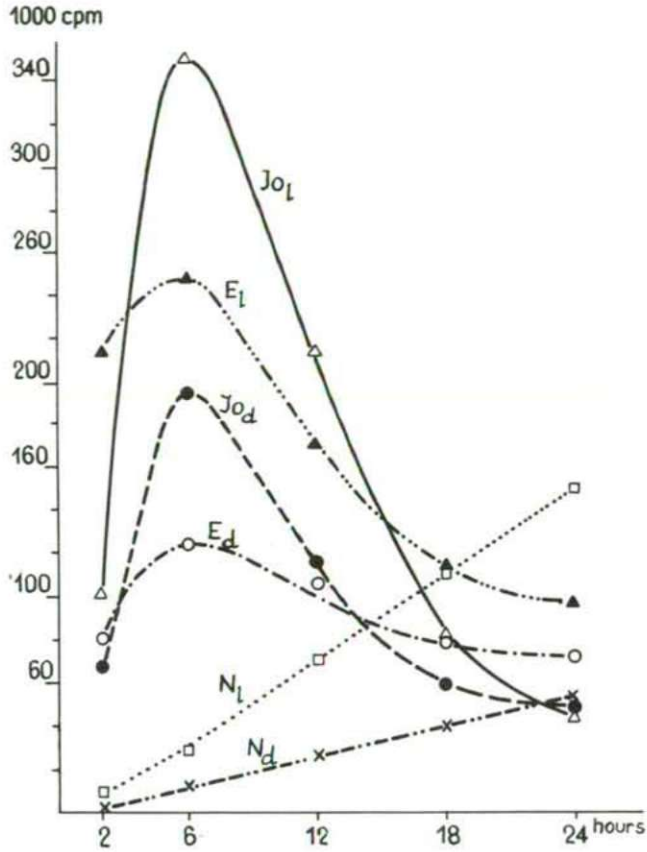

Figure 2. Radioactivity of the alcohol soluble ^{32}P fractions of pea shoots according to the time and light conditions.
Io_l = inorganic phosphate in the light
Io_d = inorganic phosphate in the dark
E_l = ester phosphate in the light
E_d = ester phosphate in the dark
N_l = nucleotide phosphate in the light
N_d = nucleotide phosphate in the dark

2. The Change of the ^{32}P Activity of Roots and Shoots during the Experiments in the Case of Different Light Conditions.

Fig. 2 shows that the amount of inorganic phosphates increased continuously whether the seedlings were kept in the dark or in the light. During the incubation period the activity of ester-fraction increased similarly, but the total activity was higher in the seedlings kept in the light, than it was in darkness. During the experiments the curve of phosphate compound didn't show any maximum.

Fig. 3 shows that the activity of the roots was higher than it was in the same fractions of the shoots. After six hours the amounts of the inorganic phosphates and of the organic phosphate ester fractions

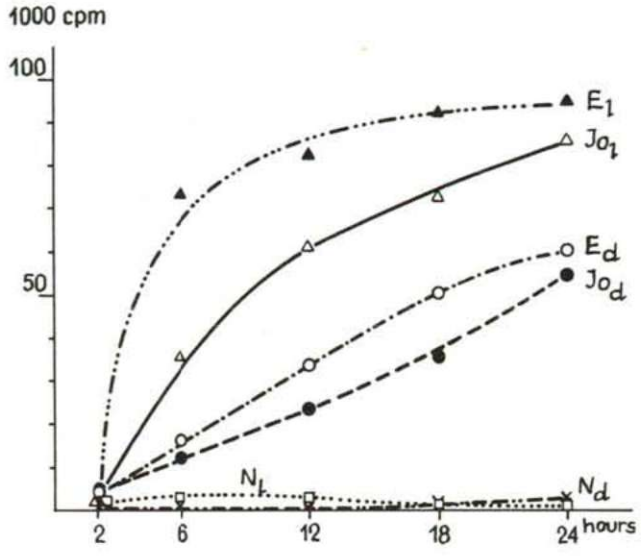

Figure 3. Radioactivity of the alcohol soluble ^{32}P fractions of pea roots according to the time and light.

Io_l = inorganic phosphate in the light
Io_d = inorganic phosphate in the dark
E_l = ester phosphate in the light
E_d = ester phosphate in the dark
N_l = nucleotide phosphate in the light
N_d = nucleotide phosphate in the dark

of the roots show a maximum on the basis of activity. The maximum was higher in the roots of seedlings kept in the light, than it was in the other case. After the maximum the activities of both fractions decreased and an equilibrium occurred after 18—24 hours.

The phosphate incorporation into the nucleotid fraction was continuous in both cases in the roots and similarly in the shoots during the experiments.

The activity of „indole"-phosphate fraction showed unambiguous increasing tendency when the seedlings were kept in the dark.

3. The Ratio of Single Fractions in the Percentage of Total Activity According to the Time and Different Light Conditions.

For the explanation of the experiments it was very important to compare the ratios of the measured activity of single fractions in the percentage of alcohol soluble ^{32}P activity. The data calculated in this way are in Table 1 and Fig. 4.

According to the data the calculated ratio of activities of the shoots of seedlings kept in the dark had a maximum of inorganic phasphates before the first sample was measured. This value was constant for 6—18 hours and it increased slightly after this period.

TABLE 1. Incorporation of ^{32}P into the different phosphate fractions of the shoots and the roots of pea seedlings according to the time and light conditions

Fraction		2h		6h		12h		18h		24h	
		C_{pm}/g	%	C_{pm}/g	%	C_{pm}/g	%	C_{pm}/g	%	C_{pm}/g	%
S_d	Io	5642	54,53	12178	41,54	23506	40,78	35679	40,42	54296	46,00
	E	4585	44,31	16987	57,95	33040	57,32	50416	57,12	60842	51,55
	I	88	0,85	86	0,29	216	0,37	322	0,36	457	0,38
	N	31	0,30	65	0,22	880	1,53	1844	2,09	2446	2,07
	T	10346		29316		57642		88261		118041	
S_l	Io	2087	40,79	44996	35,62	61410	42,10	73240	46,66	88482	50,47
	E	1909	37,31	76372	60,45	78804	54,03	82571	52,60	85736	48,91
	I	76	1,49	2831	2,24	3200	2,19	980	0,62	632	0,36
	N	1044	20,41	2140	1,69	2445	1,68	1218	0,78	452	0,25
	T	5116		126339		154859		157000		175302	
R_d	Io	67979	44,00	195249	57,22	116210	45,91	59407	32,25	46793	26,22
	E	81569	52,80	124217	36,40	104060	41,12	79202	42,90	72226	40,46
	I	1061	0,69	4501	1,32	4805	1,90	5112	2,78	5960	3,34
	N	3885	2,51	17262	5,06	28004	11,06	40473	21,97	53498	29,58
	T	154494		341229		253079		184194		178477	
R_l	Io	100117	30,88	349763	54,69	214520	54,87	81420	25,42	42335	13,74
	E	215525	66,48	248864	38,91	170218	36,40	114042	35,59	97575	31,67
	I	935	0,29	10949	1,71	12602	2,69	14806	4,62	18457	5,99
	N	7608	23,45	29982	4,69	70320	15,04	110129	34,37	148752	48,60
	T	324185		639558		476660		320397		308109	

S_d = shoots of seedlings kept in the dark
S_l = shoots of illuminated seedlings
R_l = roots of illuminated seedlings
R_d = roots of seedlings kept in the dark

Io = inorganic phosphate
E = ester phosphate
N = nucleotide phosphate
I = „indole"-phoshate

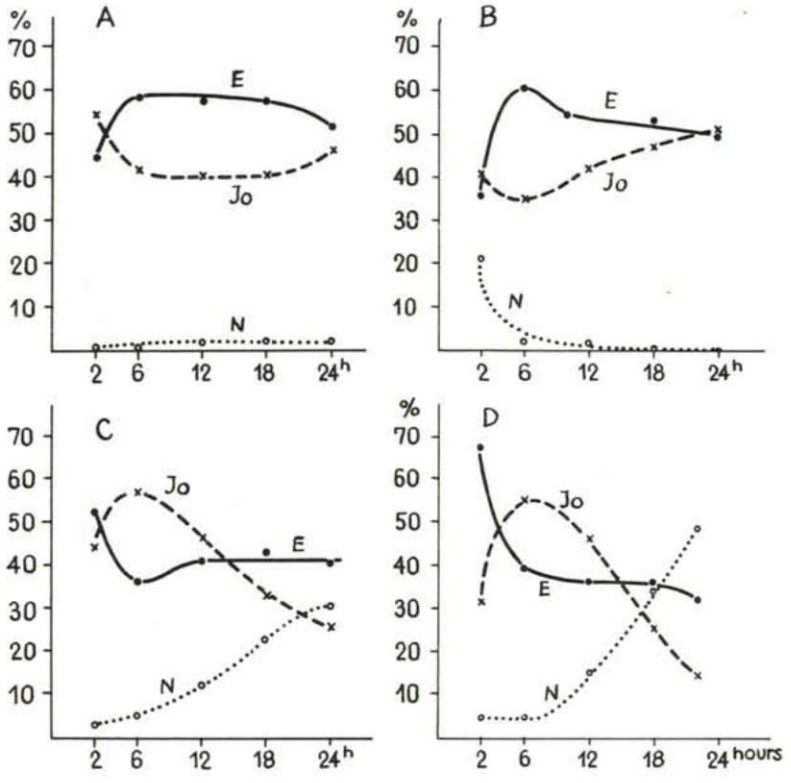

Figure 4. Radioactivity of phosphate fractions in the percentage of the incorporated total ^{32}P according to the time and light conditions.

Io_l = inorganic phosphate in the light
Io_d = inorganic phosphate in the dark
E_l = ester phosphate in the light
E_d = ester phosphate in the dark
N_l = nucleotide phosphate in the light
N_d = nucleotide phosphate in the dark

The curve of ester fraction didn't show any characteristic maximum but the percentage of the incorporated ^{32}P was almost continuous. The participation of the nucleotide fraction in the total activity raised slowly and fluently. After a time the activity of them was about constant. The illuminated seedlings showed similar change but it was significant that the activity of nucleotide fraction had a maximum before the examined first sample (Fig. 4B). The percentages of ^{32}P fractions of the roots kept in the dark or in the light were approximately similar. The changes of the inorganic and of the nucleotide fractions were strong and of contrary character (Fig. 4C and D).

Discussion

A programme of the present work was to select the suitable parameters for the examination of some physiological processes. We have found a method that gave possibility to separate the phosphate compounds and to establish the qualitative and quantitative ratios of them at different conditions.

Similar experiments were carried out by Simonis and Weichart in 1958, Weichart in 1961 with Helodea, by Loughman in 1960 with potato parenchyma tissues and at least by Heitefuss in 1961 with the leaves of wheat and with intact wheat plants.

The mentioned papers described experiments and results after a short few minutes incubation period or after a few days incubation. The authors have not examined yet how the phosphate concentration changed in a few hours period. For the registration of experimentally inducated growth the above mentioned period was selected because the 10—20 minutes experiments didn't give valuable data about the growth. After a longer period there were a lot of side reactions, which could disturbe the results.

On the basis of the experiments the authors established that the total activity of ^{32}P fractions and the percentile participation of phosphate compounds in the case of examined seedlings showed more or less change either in the light or in the dark in the first 6—8 hours period. After 6—8 hours an equilibrium formed, that didn't change for 18—24 hours. This result was very significant for the seedlings kept in the dark.

There was a maximum of ^{32}P activity in the roots after six hours. The activity decreased quickly after this period, because the fast uptake of inorganic phosphate was followed by transportation into the shoots and by formation of alcohol insoluble compounds.

In the shoots the total activity increased continuously, however the percentile amount of inorganic and esterphosphates were approximately constant after a few hours. The effect of the light increased the total activity of phosphate compounds and it also increased the formation of free nucleotides. Higher acitivity of nucleotides was found also in the roots.

The experiments have given a view about the dynamics of the incorporation of ^{32}P and how the light effect changed the phosphate incorporation. The experiments have given a lot of data about the transport of phosphate compounds that was not explained in detail.

On the basis of experiments the authors established that for studying the effects of growth regulators the seedlings kept in the dark are suitable.

Summary

It was examined how the qualitative and quantitative ratios of phosphate compounds changed with the light effects in a 24 hours period. Results of the experiments showed that the light effects changed on differential way the total acitivity of the roots and the ratio of differential phosphate compounds. There was always found a higher acitivity in the roots than in the shoots. The time curve of activities measured in the root extract gave a maximum, while the incorporation into the shoots was continuous. The light increased the incorporation of ^{32}P both into the roots and into the shoots. In the roots the Cpm activity of the inorganic phosphates decreased after six hours calculated by the separated fractions of phosphate compounds. Similarly the percentile activity of inorganic phosphate decreased after six hours. The activities of organic fraction increased fluently. Probably they formed from the incorporated inorganic phosphates. This transformation resulted a decreasing of the activity of inorganic phosphates.

These experiments gave at first data for the qualitative and quantitative change of so-called „indole"-phosphate fraction. These compounds can be very important physiological active compounds. Into this fraction the incorporation of ^{32}P increased continuously in the roots with the time. During the experiments the „indole"-phosphate fraction of the shoots didn't show any unambiguous tendency. On the basis of the mentioned character of „indole"-phosphates, they are similar to the nucleotide fraction.

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AMMONIA POISONING IN CARP. 3. THE OXYGEN CONTENT AS A FACTOR INFLUENCING THE TOXIC LIMIT OF AMMONIA

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Introduction

The nitrogen content of the water and mud of fish ponds influences to a great extent the productivity of the pond. It is proved that the amount of ammonia due to the breakdown of proteins or applied as fertilizer is an essential factor in the multiplication of the microorganisms which are important food for the fish. This is why more and more reports deal with the results of the application of nitrogenous fertilizers. But the ammonium influencing the productivity of the pond favourably may, but under certain circumstances, become harmful and cause rapid perishing of the fish (Woker, 1949; Schäperclaus, 1952, 1957). Poisoning caused by so-called free ammonia can occur understandably first of all in fish ponds established on alkaline soils and in ponds with alkaline water where it may cause sterility of shorter or longer duration. A good example of the latter cause is the pond Kunfehértó near Kiskunhalas, between Tisza and Danube. Only 3—4 years ago there was no fish life at all in this pond. It was easy to find the cause of this, because at that time the water of the pond was extremely alkaline. Its pH value varied between 10,1—10,3 and its ammonium content between 0,5—0,7 mg, free ammonia 0,48 mg/l. Populating the pond with carp did not produce the expected result either. At the beginning of the warm weather when the temperature of the shallow water soon reached 20—25 C° the populated fish colony perished. This year (1967) however, the abundant spring rainfall raised the level of the pond by 100 cm, and in consequence of the greater dilution the pH value fell to 8,3. Perishing of the fish did not occur in spite of the long-lasting warm weather and the population developed undisturbed. It is hoped that there will be no trouble in the future until the water of the pond regains its former concentration in a drier period.

Material and method

The experiments were carried out at the State Fish Farm of Szeged and the investigations also in ohetr fish ponds with alkaline water where mass decay of fish due to ammonia occurred.

The examinations were carried out by Prof. Winkler's methods well-known in limnology (Maucha, 1930).

Experimental

We have stated that in our ponds with very alkaline water the pH value of which is over 9 the presence of even a very small, less than one mg/l ammonia is enough to cause perishing of the fish. While the water of the ponds is neutral or nearly so, even a larger amount of 10—15 mg/l ammonium ions does not constitute a danger. In the alkaline waters, however, the ammonium transforms into free ammonia which being a poison may also poison the fish. Besides alkalinity the longlasting warm temperature is also an important factor in the transformation because at a higher temperature the formation of free ammonia is also more intensive. For instance in water with pH 8,5 and a temperature of 17 C° only 10 per cent of the ammonium transforms into free ammonia while at 25 C° in the same water 15 per cent and at 30 C° 20 per cent. This means that the longlasting summer heat, partly by increasing the alkalinity, partly by raising the temperature of water, increases the danger of fish as an effect of ammonia and this may even occur regularly.

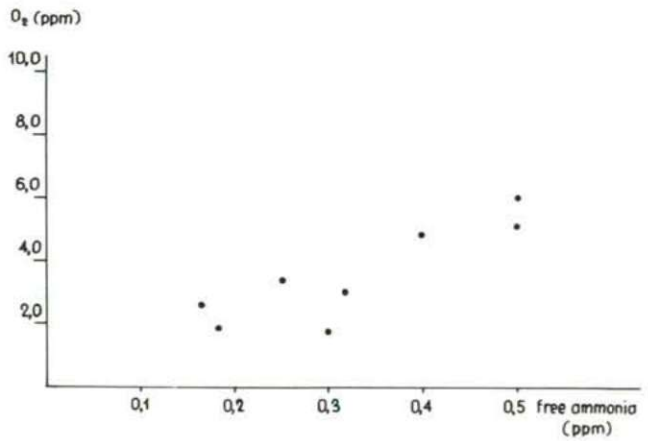

Fig. 1. Oxygen content of the water at time of the fish decays caused by ammonia.

In order to determine the toxic limit value of the free ammonia we conducted a series of experiments at the Szeged State Fish Farm in previous years. In the course of these experiments it was ascertained that the lethal limit value of the free ammonia is around 0,5 mg/l in the case of the carp (Vámos and Tasnádi, 1961; Vámos, 1963). These experiments, however, were carried out not in original fish pond

water but in water from a bored well containing 5—6 mg/l of oxygen. During these experiments also the characteristic reactions provoked by the ammonia were noted. In the following years, however, we learned several cases of rapid fish decay caused by ammonia in which the amount of so-called free ammonia was below 0,5 mg/l. Such decay of fish occurred most recently on the 7th of August 1967 in the pond No. X. of the Szeged Fish Farm where at the beginning of the decay the mother carps as well as smaller fish swam about in the surface layer of the water and flapping in vertical direction they jumped out of the water. This perishing damaged especially the stock of mother carp. The oxygen content of the water was only 1,4 mg/l, the ammonium content 0,8 mg/l, the temperature of the water 25 C°, the pH 9,1 i.e. the free ammonia content may have been around 0,3 mg/l.

In the cases of perishing of fish that came to our notice we made determinations of oxygen, ammonia and pH. Fig. 1 shows the results. From the results shown in the figure we can conclude that the toxicity of the free ammonia determined by the three factors (pH-value, NH_4^+-content and temperature) becomes less with the decrease of the oxygen content. Perishing of fish occurred also when the amount of free ammonia was only 0,2 mg/l. This means that in insufficient oxygen supply of the fish the toxic limit value of ammonia is diminished.

A further task was to find out what could be the cause of the marked decrease of oxygen, and the cause of the fact that on a sunny afternoon when the algae assimilate undisturbed and produce oxygen the water contained only 1—2 mg of oxygen per litre. The already well-known restlessness of the fish indicated the danger definitely where else 10—12 mg/l of oxygen was found before 2—3 hours.

Investigating such cases of damage so far, as Veszprémi (1964) has also stated, a decrease in atmosperic pressure has always been involved, i.e. in all such cases of fish decay a decrease was observed in the atmospheric pressure. So it was also with the last cases examined in Szeged. The atmospheric pressure changes in the period of the perishing are shown in Fig. 2. The causal relation between the decrease of the atmospheric pressure and the decrease of the oxygen content of the water can be explained as follows.

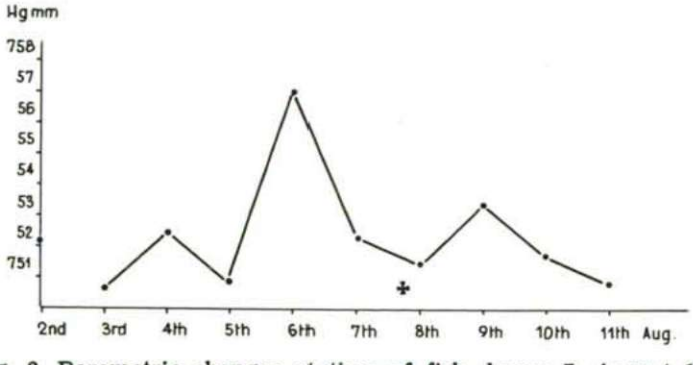

Fig. 2. Barometric changes at time of fish decay: 7. August 1967.

The role of the decrease of atmospheric pressure

It is well known that the decomposition of the organic matter in the mud is accompanied by intensive gas production. The gases form according to the evidence of our model experiments, small caverns and accumulate. The main factors of the gas formation of the mud are the temperature and the amount of organic matter to be decomposed. In fish ponds with thin water cover the gas production is more intensive because of a greater degree of warming.

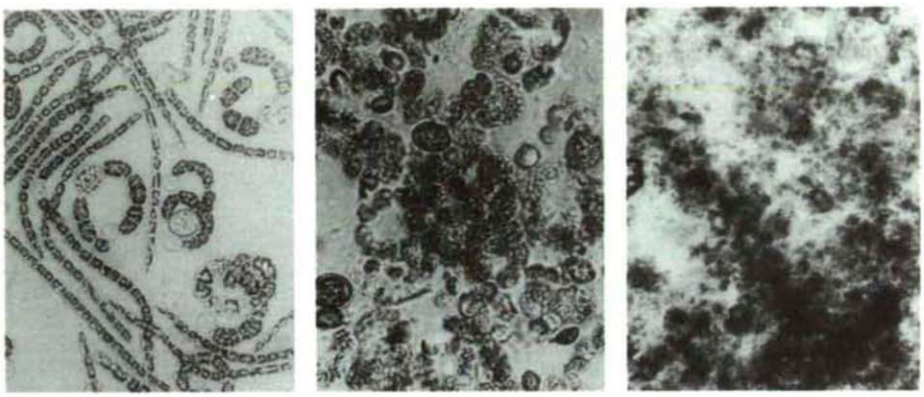

Fig. 3. Disintegration of the algae at the time of fish decay.

When the atmospheric pressure falls the air pressure on the water layer decreases and the gas bubbles appear on the surface of the water. The rising gas bubbles carry mud particles a large part of which is of organic colloids. Then the turbidity of the water increases, and the facultative anaerobic bacteria doing the work of decomposition of the particles begin to multiply rapidly in the water under more favourable conditions. The multiplication depends on the better oxygen supply. The higher temperature in the mud is 18—20 C°, however that of the surface layer of the water is 25—30 C°. It was be stated that the number of the bacteria in 1 ml of water can in a few hours, grow several hundred times. The multiplying bacteria may form a continuous film on the surface of the water. The multiplication of the bacteria was proved using Petri dishes and dark fields. The increased oxygen consumption of the bacteria has an unfavourable effect on the algae. If the amount of the oxygen sinks below the quantity necessary to the normal respiration of the algae this condition may disturb the assimilation, i.e. the oxygen production of the algae. This is why we could measure 1,3—1,7 mg/l oxygen content in glaring sunlight in the early afternoon hours even though the number of algae was 210—340 million. The algae with disturbed metabolism may later be attacked by bacteria. Thereby begins the massive dying and disintegration of the algae.

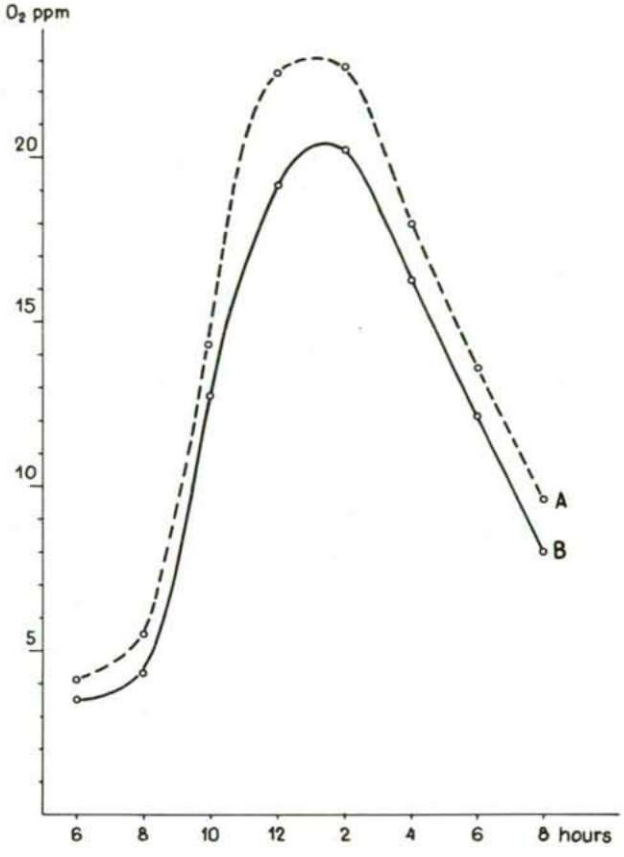

Fig. 4. Changes of oxygen content on a sunny day. A = without mud, B = with mud.

In order to find out whether the bacterium flora of the mud influences the oxygen content of the water we made the following model experiment. For the experiment we used two six litre glass containers. On the bottom of one 1,0 kg of garden soil was put, its organic matter content was 5,6 per cent. Then into both 5 litres of the same kind of pond water was poured in which the original number of algae was 140 million/l. The containers were kept in a glasshouse. After three days, oxygen determinations were made in every hour. The results are shown in Fig. 4. and Fig. 5. As it can be seen from the figure, the bacteria living in the mud and decomposing the organic materials, as consumers, play a part in the reduction of the oxygen content of the water. The oxygen content in the jar containing mud was smaller than in that without mud.

Fighting down ammonia poisoning

After finding out the above facts we could think of the following possibilities to prevent ammonia poisoning:

1. Increasing the oxygen content of the water.
2. Decreasing the high pH-value.
3. Binding the free ammonia.

It is possible to increase the oxygen content if we have a water supply of sufficient quantity and suitable quality at our disposal.

Unfavourably high pH value may be reduced partly by dilution with water in which the pH-value is low, as described above, and partly by chemical treatment. In the latter procedure the application of cheap sulphuric acid may first of all come into consideration.

To bind the poisonous free ammonia the use of cupric sulphate has so far proved the most successful. The cupric sulphate was dissolved in the boat and from there poured out into the pond. As every cupric ion can bind 4 molecules of ammonium hydroxide, a relatively small amount of cupric sulphate is sufficient for binding the ammonia and is not dangerous to the fish either. Practice justified our theoretical calculations. 2,5 kg of cupric sulphate calculated for one hectare and 60 cm depth, proved sufficient for binding 0,2 mg/l of free ammonia.

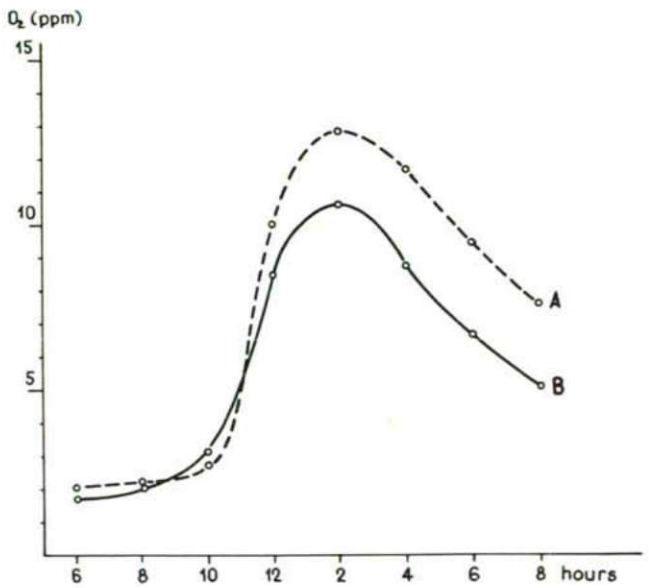

Fig. 5. Changes of oxygen content on a day with inconstant weather. A = without mud, B = with mud.

Summary

The authors have conducted experiments in order to determine the toxic limit of free ammonia and to known the symptoms caused by it. The experiments were made with carp in tap water. The toxic limit was 0,5 mg/l of free ammonia. In recent years several such cases of mass decay of fish due to ammonia occurred in which the toxic limit was below 0,5 mg/l. In the course investigating the cases of fish decay a relation was found between the amount of toxic free ammonia and the oxygen content of the water. It was stated that with the reduction of the oxygen content the toxic value of the free ammonia also decreases.

The application of dissolved cupric sulphate proved succesful against the toxic effect.

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ON THE MECHANISM OF GIBBERELLIN-AUXIN INTERACTION

IV. EFFECT OF GIBBERELLIN TREATMENT ON THE OXIDATIVE DESTRUCTION OF INDOLEACETIC ACID IN BEAN HYPOCOTYL TISSUES

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(Received October 17, 1967)

Introduction

In our earlier works it was shown that due to the effect of gibberellin (GA) the quantity of the different indoleacetic acid (IAA) forms increases in the bean hypocotyl tissues. Namely, according to our experiments, not only the free IAA level is enhanced by GA treatment, but the formation of the IAA-conjugates and IAA-macromolecule complexes are promoted too (Varga and Bitó, 1968; Varga, 1968). Thereupon the question arose, by what kind of mechanism the GA-induced rise of IAA level is realized in the bean hypocotyls. According to our earlier results, the increase of the quantity of IAA is greatly the result of the fact that GA promotes the IAA synthesis; in detail, it enhances the utilization of tryptophan (TTP) precursor in the biosynthesis of auxin (Varga et al., 1968). However, since several authors have shown that GA can control the auxin concentration in plant tissues by affecting the IAA oxidase acivity, it may be supposed that also in bean hypocotyls — beside a stimulated TTP ⟶ IAA conversion — an „auxin-sparing" mechanism is in action. Consequently, the IAA-oxidase activity in GA-treated and untreated hypocotyls was examined and compared in detail.

Material and method

Phaseolus vulgaris (var. *Golden Rain)* seedlings were grown as described earlier (Varga and Bitó 1967). On the 5th day the seedlings of the same size were selected and having removed the cotyledons, hypocotyls of 3 to 3.5 cm were used for experiments. From one part of the hypocotyls the shoot apex was cut (decapitated hypocotyls) and kept on the others (intact hypocotyls). Hypocotyls were incubated for 24 hours — one series in light (6000 lx), another in dark —

in growth medium containing 0, 5 and 50 ppm GA_3. After 24-hours incubation the IAA content and the IAA oxidase activity in the tissues were measured.

Determination of IAA oxidase activity was carried out by a modified form of Gordon-Weber's colorimetric method (1951) and by paperchromatography, as described in our earlier works (Varga and Köves 1962, Varga and Zsoldos 1963).

All examinations were conducted with four replications.

Results

The IAA oxidase activity, observed in the GA-treated and untreated hypocotyls under different experimental conditions, is presented in Fig. 1. Ordinate indicates the amount of IAA broken down in 1 hour by an enzyme preparation corresponding to 1 g fresh weight. Without GA treatment (0 ppm), both in light and dark, a greater enzyme activity could be measured in the decapitated hypocotyls; which is in full agreement with our earlier statement that in these tissues the IAA content is lower than in the intact hypocotyls (Varga and Bitó, 1967). Another conclusion can be also drawn, i.e. the oxidative

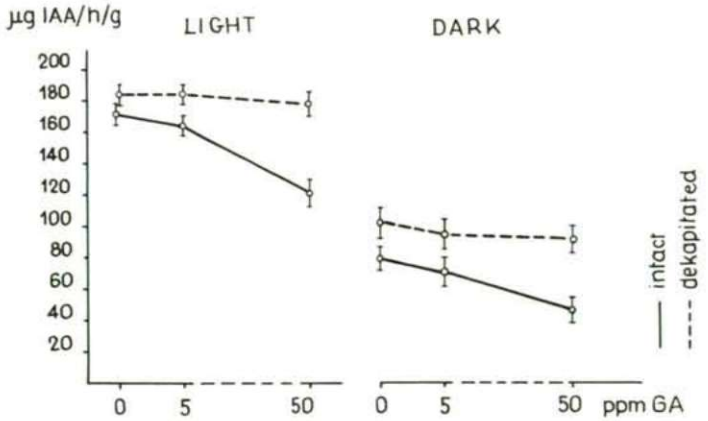

Fig. 1. Effect of GA treatment on the IAA oxidase activity.

destruction of IAA is greater in light than in dark; that is also reconcilable with the higher auxin concentration measured in dark. GA treatment apparently does not alter these conditions, however, in the intact hypocotyls — both in light and dark — it decreased the enzymatic degradation of IAA. On the other hand, GA treatment had no effect on the enzyme activity in the decapitated hypocotyls, i.e. the differences from the control are not significant.

Quite similar results were obtained with the paperchromatographic examinations too (Fig. 2), when the relative IAA quantity, remained after incubation with the enzyme, was estimated by comparing the spot size and colour intensity.

Having previously fed the hypocotyls with TTP, GA significantly enhanced the utilization of the precursor in IAA synthesis, i.e. the IAA

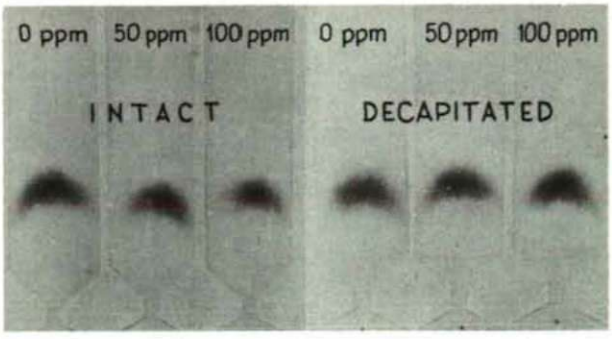

Fig. 2. Measurement of IAA oxidase activity with paper chromatography (comparison of the relative IAA quantities after incubation with the enzyme).

content of the tissues (V a r g a et al. 1967). At any rate, the IAA oxidase activity apparently was not influenced by the TTP pretreatment (Fig. 3), because the enzymatic destruction of IAA measured in this case — taking the standard error into consideration — was about the same as in the tissues not fed with TTP.

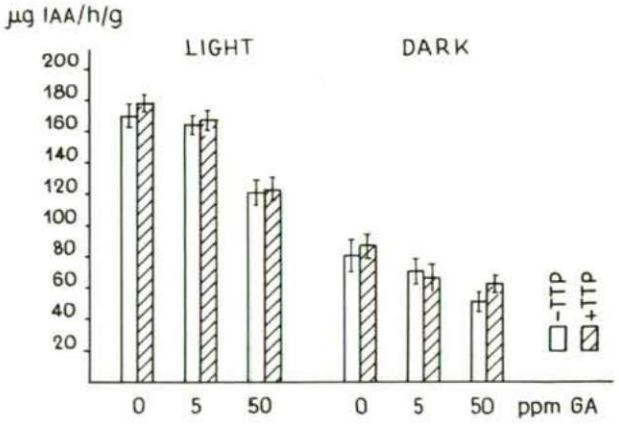

Fig. 3. Effect of TTP feeding on the IAA oxidase activity (intact hypocotyls).

Discussion

The effect of GA on the IAA-oxidizing enzyme system was studied several times in the last years and many of the authors rendered account of a decrease in IAA activity, due to the effect of GA treatment (P i l e t 1957; P i l e t and W u r g l e r 1958; G a l s t o n and M c C u n e 1961; K o n i n g s 1961; H a l e v y 1963). In some papers the observed endogen „auxin sparing" is explained indirectly, by stating that GA increases the formation of an IAA oxidase inhibitor in the tissues

(Stutz and Watanable 1957; Galston 1957, 1959; Housley and Deverall 1961; Gaspar and Bouillenne-Walrand 1966; Bouillenne-Walrand et al., 1967). According to other views, changes are induced by GA not in the inhibitor level but in the spectra of the IAA-oxidizing peroxidase system. For example, in the dwarf corn six peroxidase isozymes were found and GA treatment caused a decrease in the quantity of some of them and an increase in others (McCune and Galston 1959; Galston and McCune 1961).

On the other hand, some works lead to the conclusion that GA has no effect on IAA oxidase. E.g. the results of Kato and Katsumi (1958), Sági and Garay (1961), Kefford (1962), Varga and Bálint (1966) as well as Procko et al. (1966) do not support the idea that GA would influence the endogen IAA content by an auxin sparing mechanism.

In our experiments, in bean hypocotyl tissues, the enzymatic destruction of IAA was decreased by GA only in the present of the shoot apex and not influenced in the decapitated hypocotyls. Furthermore, the relatively slight decrease of IAA oxidase activity, observed in the intact hypocotyls, is not proportionate to the rate of the simultaneous rise of IAA level, nor to that of the stem elongation. Consequently, we can conclude that the GA-induced enhancement of IAA can not be ascribed merely to sparing the auxin from decomposition, as GA increased the IAA content even in cases when it did not decrease the enzyme activity, i.e. in decapitated hypocotyls. Thus, the higher IAA level induced by GA can be attributed only partly to an auxin sparing effect; this phenomenon — as results prove — can be caused rather by the direct promotion of IAA synthesis.

Pretreatment of the hypocotyls with TTP resulted in a significant rise of IAA concentration in the stem, but the IAA oxidase activity remained unchanged. Hence, in our experiments no adaptive formation of the enzyme could be observed, i.e. rising the substrate concentration the IAA oxidase activity (or synthesis) increases (Galston and Dalberg 1954; Gaspar 1965; Garay 1967).

In our experiments, both in the GA treated and untreated hypocotyls, the enzymatic destruction of IAA was greater in light than in dark. Similar statement was made by Galston (1957) working with dwarf pea, further by Stutz (1957 and Garay (1967) with *Lupinus albus*. According to the latter author, light increases the breakdown of IAA in the stem very likely by inducing a *de novo* synthesis of IAA oxidase.

Moreover, the results proved that the presence of the shoot apex plays also an important role in the connection of IAA oxidase with GA, since GA treatment influenced (decreased) the auxin destruction only in the intact hypocotyls. In all probability this is a symptom of the correlation; and that IAA oxidase activity can be influenced also by correlative effects, has been observed by other authors too (Garay 1967).

Summary

In bean hypocotyl tissues, in the presence of the shoot apex, GA treatment decreased the IAA oxidase activity, but it had no effect in the decapitated hypocotyls. Since GA enhanced the IAA content in hypocotyls even in cases when it did not alter the enzyme action, the GA-induced increase of IAA level can be ascribed only partly to saving the auxin from the enzymatic destruction. The higher IAA concentration in the GA treated tissues can be attributed rather to the direct promotion of IAA biosynthesis.

The action of GA exerted on IAA oxidase is influenced also by light and the presence of the shoot apex.

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THE ION UPTAKE OF RICE PLANTS AT DIFFERENT pH VALUES

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The different requirements of the several rice sorts for nutritives are well known, concerning their physiological causes, however, we haven't any data at all. The utilization of the nutritives being, in high degree, a function of external factors (pH, light relations, temperature, etc.), therefore, e.g., if a chemical fertilizing procedure is introduced, we must take into account their physiological effect, as well.

Among the external factors the actual pH relation of the soil (water culture) plays a very important role. This, namely, affects, as known from the examinations of a lot of authors, in high degree the intensity of uptake of some nutritives (ions) (Sutcliffe, 1962; Jennings, 1963; Kürten, 1954; Fried et al., 1965; Wallace, 1963). As Hungary, too, is getting on with growing different rice sorts in several soil types, the examination of that and of similar problems seems to be reasonable.

Material and method

At our examinations there have been used the rice sorts Dunghan Shali *(Oryza sativa* var. *japonica)*, Dubovsky—129 *(Oryza sativa* var. *japonica)*, and Nhang Mon S—4 *(Oryza sativa* var. *indica)*. The test plants were grown in greenhouses (by 5.500 Lux), in water culture. Composition and method of the nutritive solution were discussed in details already earlier (Zsoldos, 1966).

For a continuous control of the pH of the nutritive solution, a measuring instrument with recording apparatus has been employed, by the help of which the so-called rhythm-change was measured, too. The setting of pH and its correction from time to time was performed with the aid of 0,1 n HCl or 0,1 n NaOH. For isotopic tracing P—32 and Rb—86 were used. The absorption solution, in which uptake and pH change was measured, was a saline solution of 5×10^{-4} M. During the investigations the activity of the different organs was measured directly and the results are expressed related to dry material (μmol/g). The roots were rinsed in distilled water three times (in a minute) after being taken out of the active solution. In the course of our experiments, there were applied at each occasion fifty 10—12 days old rice plants grown

under similar conditions (in three repetitions). The stabil isotopes have been determined by mass spectrometer as described by Fried and co-workers (1965). The results are expressed in relation to dry material (μg/g).

Experimental results

During the examination of our water cultures it was ascertained that in a nutritive solution the change of pH took very quickly place, influenced, of course, in a high degree by the ration of roots and fluid. The data

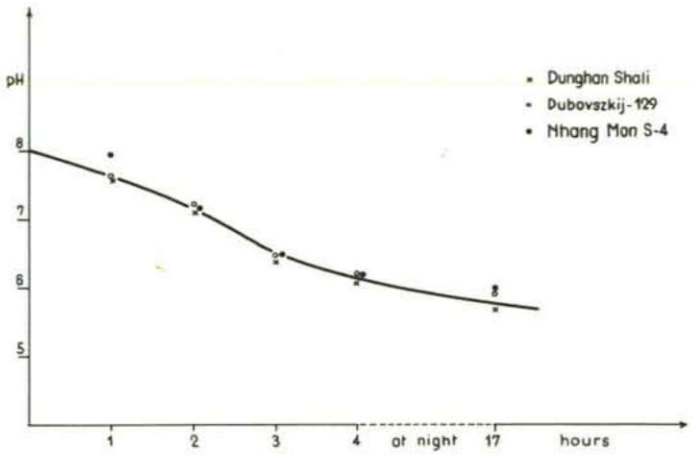

Figure 1. Examination of the change of pH-values by rice plants in a water culture.

of Fig. 1 are demonstrating well, that in an alkaline solution (pH = 8), a considerable decrease of pH can be observed in a short time after the beginning of the experiment. In case of acid or weakly acid nutritive solutions (pH = 4 and 6 resp.) a pH dislocation can be observed but after a longer time in the direction of the acid side, just as in case of an alkaline soluition.

The change of pH during the night is demonstrated similarly in Fig. 1. In this case, too, it keeps on decreasing getting to the minimal value in the morning following the beginning of the experiment. After that a minor pH increase can be observed.

In the course of our sort-comparing examinations, under the conditions investigated, there couldn't be found any major differences concerning the single rice sorts (Fig. 2). We have observed, anyhow, although demonstrated but a little by the graph, that the change of pH is slower in case of rice of indica type than at the other sorts.

We may consider interesting the experimental results in case of which the changes of pH of different absorption solutions were compared with one another at rice sorts of indica and japonica types. The obtained results are partially in harmony with the data of Fig. 1 as, at an

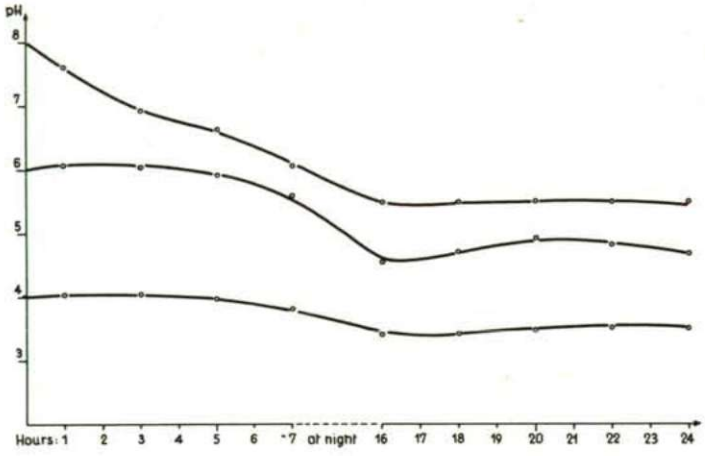

Figure 2. Change of pH-values by different rice sorts in a water culture.

examination of short duration, a major change of pH can be observed only if an alkaline solution has been applied (Table 1). It can be observed, as well, that the change of pH is more considerable at RbCl than in case of KH_2PO_4. This may be explained obviously by a different intensity of the anion-cation uptake. Among the different sorts there haven't been observed any considerable differences.

TABLE 1. Change of pH-values of the nutrition solution using different salts.

Rice sort resp. type	pH value at the beginning of the experiment	pH value after 120 minutes	
		RbCl	KH_2PO_4
Indica	4	4.05	4.10
"	6	5.85	5.90
"	8	6.70	7.25
Japonica	4	4.00	5.85
"	6	5.85	4.00
"	8	6.50	7.60

Concerning the intensity of the anion and cation uptake, as it was to be expected, considerable differences can be established in case of young rice plants, as well. Our results are demonstrated in Table 2. The data of the Table demonstrate also that in an acid medium both the uptake of phosphorus and that of rubidium are more favourable.

We hold as very remarkable the change of activity in the shoot of the single rice sorts, making possible a conclusion concerning the rate of ion transportation. It is interesting from that point of view to compare the intensities of root and shoot elongation of some two days old rice sorts

TABLE 2. Effect of pH on uptake and transport of Rb and P-ions (Uptake time: 60 minutes).

Rice sort	pH	Rb-uptake in μM/g D. W.		P-uptake in μM/g D. W.	
		root	shoot	root	shoot
Dunghan S.	4	107.2	4.28	28.8	0.81
„	6	101.3	4.83	18.7	0.78
„	8	72.0	3.99	15.5	0.29
Dubovsky	4	104.6	3.75	27.9	0.56
„	6	102.2	3.74	21.8	0.33
„	8	100.9	4.37	17.9	0.71

(Fig. 3). First of all Dunghan Shali differs from the others in growth rate of the shoot. The data of Table 2 call our attention also to the fact that, after an experimental time of one hour, a considerable part of the ions uptaken is accumulated in the roots since but a small part of the tracing isotopes got to the shoot.

Table 3 is demonstrating the uptake of nitrate and ammonium nitrogen at different pH values. The data of Table correspond thoroughly to the results of the experiments already made known and to other literary data referring hereto, as well.

TABLE 3. Effect of pH on uptake and transport of different N-compounds. (Uptake time: 90 minutes).

pH	NO_3-N uptake in μg/g D. W.		NH_4-N uptake μg/g D. W.	
	root	shoot	root	shoot
4	80.9	8.1	242.0	19.2
6	69.4	7.1	362.0	18.4
8	47.4	10.5	369.8	20.4

Discussion of results

The very important physiological role of pH is generally known. But there are comparatively few experiments concerning intact higher plants. An explanation of that may possibly be the fact that it is considerably easier to work with excised roots or micro-organisms than e.g. with intact plants. Our first and important ascertainment is that the change of pH in the nutritive solution takes place very fast, in fact in a few minutes. This is, of course, affected supposedly in a high degree by the ratio between the mass of root and the amonunt of the nutritive solution, as well. The change, as seen in Fig. 1, is particularly obvious in an alkaline medium. The close connection between the hydrogen ion concentration of the nutritive solution and the ion uptake may have different causes. Thus e.g., in the ion absorption of phosphate the pH

plays a particularly important role as, apart from the physiological effect, there follows here a considerable change in the ion form, as well. As the pH value rises the monovalent form ($H_2PO_4^-$) becomes divalent (HPO_4^{--}) and finally, the solution becoming strongly alkali, there exists only trivalent phosphate (PO_4^{---}). The latter one can, however, not be utilized by plants.

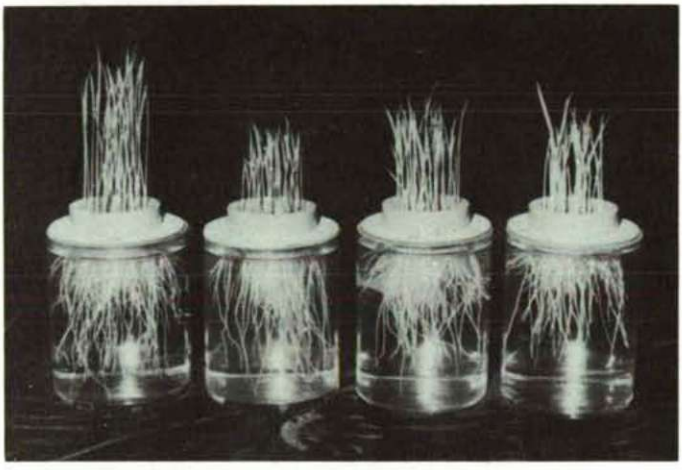

Figure 3. Rice sorts growing in nutrient solution. From left to right: Dunghan Shali, Dubovsky—129, Uzros—17, Nhang Mon S—4.

The considerable difference observed between the intensities of the anion and cation uptake is not surprising if we realize that the exchange capacity of cations is usually multiple of that of the anions, as demonstrated by several literary data.

It was demonstrated already in the course of earlier experiments by the help of stabil isotopes, too, that at experiments of short duration the optimum of pH of nitrate-N uptake is 4,0—4,5 while in case of ammonium-N the optimal pH is about 8 (Fried et al., 1965). This statement is supported repeatedly by our own experiments and it appears from the data that the acid, resp. the weakly acid medium (pH 5,5—6,5) may generally be considered optimal for rice. This, anyway, entirely agrees also with the practical observations (Kürten, 1954). We want to notice that the more intensive uptake of NH_4-N, observed in alkali solution, may not at all be considered really optimal as in that case we have already to reckon with some free NH_3 well-known as a cell-poison and a substance troubling the growth (Vines and Wedding, 1960; Varga and Zsoldos, 1963).

An important part of our experimental results is a comparison of the amounts of ions transported into the shoots in case of different rice sorts (Table 2). It is obvious that at the sort Dunghan Shali the ion content of shoot is considerably higher although the rate of root growth

is similar to that of sort Dubovsky. Although the ion uptake may be affected by the endosperm content of germinating plants, as well, nevertheless in this case where we have worked with isotopes it cannot be considered a methodical mistake. In fact, taking into consideration the physiological qualities of Dunghan Shali and the way how it utilizes the nutrients, by all that our opinion is supported that we are facing here a sort-peculiarity. Accordingly, some sort-peculiaritites can be demonstrated by such and similar methods.

Summary

In case of a few rice sorts the pH change that takes place in the nutritive solution has been examined during experiments of short and longer durations. It has been ascertained that, particularly in alkalic media, a considerable change of the pH occurs into acid direction even if examined but for a very short duration. At night the pH value got to its lowest level in the course of which we have measured a pH value of 3,8. The uptake of different ions is affected in a different way by the pH of the nutritive solution. Generally an acid medium (5,5—6,5 pH) may be considered optimal for rice, NH_4-N making, however, an exception. Concerning the amount of ions transported into the shoots we have observed considerable differences at the different sorts. Among the sorts examined by us, the shoot of Dunghan Shali contained the most isotopes from which an intensive metabolism can be concluded showing well also the vitality of this sort.

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BEITRÄGE ZUR ALGENFLORA DER NATRON- (SZIK-) GEWÄSSER UNGARNS. I. EUGLENOPHYTEEN AUS DEM TEICH ÖSZESZÉK

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Einleitung

Unter den kontinentalen Gewässern von höheren Salzkonzentrationen sind jene Seen und Teiche, deren Chemismus durch einen extrem hohen Gehalt an Carbonaten und Bicarbonaten gekennzeichnet ist, im Weltmasse wesentlich seltener, als die Chloridgewässer. Allerdings gibt es etliche geographische Landschaften, wo Gewässer dieser Art vorherrschend sind. Zu diesen letzteren Gebieten gehören die Grosse Ungarische Tiefebene (das Alföld) und teilweise auch die Kleine Ungarische Tiefebene (das Kisalföld).

Von ungarischen und österreichischen Forschern wurde es bereits seit längerem erkannt, dass die Teiche der Grossen und Kleinen Ungarischen Tiefebene einen ganz besonderen Typ unter den Salzseen darstellen, die chemisch mit den Sodaseen verwandt sind, obgleich sie in erster Linie nicht durch Soda (Natriumcarbonat), sondern eher durch einen mehr-weniger hohen Natriumhydrocarbonat-Gehalt, also durch Bicarbonat, gekennzeichnet sind.

Wir wollen hierorts in die Besprechung der Forschungsgeschichte dieser eigenartigen Gewässer nicht eingehen, um so mehr, da wir dafür an einer anderen Stelle sorgen möchten (U h e r k o v i c h, 1967; in Msc).

Für die gegenwärtige Erforschung der ungarländischen Natrongewässer war die Bildung einer Forschungsgemeinschaft in Szeged ausschlaggebend. Diese Gemeinschaft besteht aus Geologen, Geographen, Hydrochemikern, Biologen, Mikroklimaforschern und wird vom Szegeder Ausschuss der Ung. Akademie der Wissenschaften unterstützt. Die im Jahre 1961 gegründete Gemeinschaft untersucht nach einem langfristigen Plan typische Natronteiche des Dunau-Theiss-Zwischenstromgebietes und des Gebietes jenseits der Theiss.

Meine hier vorliegende Arbeit über die *Euglenophyte*en des Natronteiches Őszeszék schliesst sich an die Reihe jener Teilveröffentlichungen, die die monographienartigen Schilderungen der ungarländischen Natronteiche vorbereiten.

Der Natronteich Őszeszék

Das Gelände zwischen der Donau und der Theiss bildet einen flachgewölbten Rücken mit niedrigen Sandhügeln, die sich in NW-SO-Richtung erstrecken. Zwischen den Hügelreihen des Rückens befinden sich Vertiefungen, die durch Deflation entstanden sind. Die Richtung der Vertiefungen, bzw. Hügel entspricht der vorherrschenden Windrichtung. In diesen durch Deflation entstandenen Vertiefungen sammelt sich Wasser an, das an vielen Stellen — den klimatischen Bedigungen und Bodenverhältnissen entsprechend — zu temporären oder ständigen Natronteichen wird.

Auch der Teich von Őszeszék, der von Szeged in Luftlinie 15 km nordwestlich liegt, ist solcher Herkunft. Der Teich ist etwa 1,2 km lang und durchschnittlich 0,5 km breit. Der Teich ist von einem Schilfgürtel umgeben und ist bei höherem Wasserstand 60—120 cm tief, dagegen schrumpft die Wasserfläche im Hochsommer und Frühherbst meist beträchtlich zusammen.

Einige oreintierende wasserchemische Daten: pH 8—10,2, meistens um 9—9,4. Na-Gehalt 204—430 mg/l, Hydrocarbonat-Ion 634—1037 mg/l, gelöste Stoffe 743—1664 mg/l. Im Vergleich zu anderen Natronteichen der Ungarischen Tiefebene ist der Teich von Őszeszék von mittelmässigem Na-Gehalt.

Zwischen 5. 5. 1965 und 10. 5. 1967 habe ich aus dem Teich zu verschiedenen, limnophenologisch planmässig ausgewählten Zeitpunkten — insgesamt neunmal — Netz- und Schöpfproben genommen, und diese qualitativ, bzw. quantitativ (nach der Methode von U t e r m ö h l) bearbeitet. Die Ergebnisse wurden haupsächlich in einer umfangreicheren Arbeit zusammengefasst (U h e r k o v i c h, 1967; in Msc); detailierte taxonomische-ökologische Ergebnisse über je eine Algengruppe werden in kürzeren Aufsätzen gebracht. Auch die vorliegende Arbeit ist eine solche.

Über die quantitative Zusammensetzung des Phytoplanktons einige Bemerkungen: Die Gesamtindividuenzahl/l-Werte zeigen die grosse Schwankung zwischen 5200 und 22500000. Die Individuenzahlen der „Salzwasserorganismen", also der limnisch-euryhalinen, euryhalin-brackischen und brackischen Algen, machen in den untersuchten Zönosen 11,94—99,11 % der Gesamtpopulation aus. Bisher wurden aus dem Teich Őszeszék 194 Algentaxa bestimmt, die Zahl der „Salzwasserorganismen" beläuft sich auf 69.

Die Euglenophyton-Arten des Teiches

Die Zeitpunkte der betreffenden Probeentnahmen sind in der Aufzählung folgendermassen vermerkt = *1:* 5. 5. 1965; *2:* 6. 9. *1965; 3:* 1. 12. 1965; *4:* 25. 3. 1966; *5:* 13. 6. 1966; *6:* 19. 9. 1966; *7:* 5. 12. 1966; *8:* 10. 3. 1967; *9:* 10. 5. 1967.

Die aufgezählten Arten gelten nach den Angaben der Literatur als limnische Arten, doch gibt es etliche, die als limnische-euryhalin zu betrachten sind (vgl. R e m a n e - S c h l i e p e r, 1958). Letzterwähnter Umstand ist in unserer Aufzählung mit „Ehl" bemerkt.

1. *Colacium vesiculosum* E h r b g. — *1, 2, 4, 9* — Von Entomostraca-Panzern losgelöste Exemplare.

2. *Euglena acus* E h r b g. — *2, 8* — 120—150×7—9 μ grosse Zellen. Nach R e d e k e (1932) kommt diese Art in Holland auch in schwach mesohalinen Binnengewässern vor, womit einige ungarländische Angaben (z.B. S z a b a d o s, 1936; K i s s, 1960; V é g h n é V a r g a, 1963) im guten Einklang sind. Somit wäre die Art als limnisch-euryhalin zu betrachten (Fig. 2).

3. *Euglena allorgei* D e f l. — *8* — Neben Individuen von der typischen Zellgrösse 100—105×13—14 μ auch solche von 78—82×12—12,5 μ (Nannoform des Salzwassers?) (Figs. 6, 7).

4. *Euglena heimii* Lefév. — *9* — 120—140 μ lange, stark metabolische Zellen. Zellgrösse kleiner als die Angabe der Literatur (vgl. Huber-Pestalozzi, 1955).

5. *Euglena limnophila* Lemm. — *2* — 85—90×19—21 μ grosse, wenig metabolische Zellen, die breiter, plumper sind, als die Angaben der Literatur, sonst aber von typischer Beschaffenheit (Fig. 9).

6. *Euglena subehrenbergii* Skuja — *8* — 210—230×28—32 μ grosse Zellen mit linkswendender charakteristischer Streifung. Neigt zum euryhalinen Charakter? Vgl. Véghné Varga, 1963 (Fig. 3).

7. *Euglena tripteris* (Duj.) Klebs — *2* — 160—170×19—22,5 μ, also mittelmässig grosse Individuen mit deutlich entwickelten Körperkanten, „Flügeln". Nach den ungarländischen Angaben (z.B. Kiss, 1959 a, 1960; Hortobágyi, 1959) scheint es mir berechtigt zu sein, diese Alge als eine limnisch-euryhaline Art zu betrachten (Fig. 1).

8. *Euglena tripteris* var. *crassa* Swir. forma? — *2* — Zellgrösse 30—33×12—12,5 μ; steht vielleicht der oben genannten Alge am nächsten, obzwar sie mehr gedrungen und ausserdem rechtsläufig gestreift ist (Fig. 16).

9. *Lepocinclis fusiformis* (Carter) Lemm. — *8* — 30—34×22—26 μ grosse Zellen, also verhältnismässig kleine Individuen. Ehl? (Vgl. dazu Kiss, 1959 b, 1960).

10. *Lepocinclis texta* (Duj.) Lemm. — *9* — 72—78×50—54 μ grosse Zellen, also grösser als die bisherigen Angaben der Literatur (vgl. Huber-Pestalozzi, 1955). Linkswendende „Haupt"- und „Nebenstreifen" (Fig. 21).

11. *Phacus aenigmaticus* Drez. — *2* Nach Zellgrösse (22—23,5×8—8,5 μ), Zellgestalt und Beschaffenheilt der Paramylonkörner typische Individuen (Fig. 15).

12. *Phacus alatus* Klebs — *8* — 42,5—45×27,5—30 μ grosse Zellen mit flügelartig verdickten Flanken, Längstreifung und zwei ringförmigen Paramylonkörnern. Die von mir angetroffenen Individuen sind weit kleiner als die der Literaturangaben (19—24×16—22 μ). Die Abgrenzung dieser Art gegenüber *Phacus lemmermanni* scheint mir fragwürdig zu sein. Überhaupt sind die *Phacus*-Arten mit flügelartig ausgebildeten Flanken, bzw. längsverlaufenden Furchen zu überprüfen. Etliche „taxonomische Unterschiede" sind hier wahrscheinlich nur auf Unterschiede in der graphischen, zeichnerischen Darstellungsweise zurückzuführen (Figs. 18, 19).

13. *Phacus ankylonoton* Pochm. — *2* — 30—32×19—20 μ grosse, also ausgesprochen kleinere Zellen als die bei Pochmann (1942), wo 35—41×17—20 μ Zellgrösse angegeben wird. Haline Nannoform? Sonst wie beim Typus, also 2 scheibenförmige Paramylonkörner, das vor dem Zellkern liegende grösser, als das weiter unten liegende, Pellicula längsgestreift (Fig. 13).

14. *Phacus contortus* Bourr. — *9* — 41—43×29—31 μ grosse Zellen, die aus 2 stark gedrehten, ungleichen, durch eine Furche voneinander getrennten Teilen bestehen. Der dicke Endstachel setzt sich in einer, neben der Längsfurche verläufenden, breiten Leiste fort. Die Art

scheint unter jenen tordierten Arten, die mit Flankenleisten versehen sind, gut abgrenzbar zu sein (Figs. 11, 12).

15. *Phacus hameli* Allorg. et Lefév. — *2* — Zellgrösse 40—45×22—25 μ, sehr feine Längstreifung, ein einziges zentrales Paramylonkorn (Fig. 10).

16. *Phacus inconspicuus* Delf. —*9* — 29—35×16—18,5 μ grosse Zellen, mit zwei seitlich anliegenden, schalenförmigen Paramylonkörnern. Ehl? (Vgl. diesbezüglich Véghné Varga, 1963) (Fig. 22).

17. *Phacus lemmermanni* (Swir) Skvor. — *2, 9* — 41—42,5×27,5—32 μ grosse, tordierte Zellen, mit verdickter Flankenleiste und Längsfurche. (S. die Bemerkungen bei *Ph. alatus!)* Ehl? (Figs. 14, 20).

18. *Phacus onyx* Pochm. — 7 — 43—46×33—35 μ grosse, seitlich charakteristisch eingekerbte Zellen mit einem grossen, zentralen und einem kleineren Paramylonkorn (Fig. 9).

19. *Phacus pleuronectes* (O. F. M.) Duj. — *2, 4, 6, 9* — 50—62×37—40 μ grosse Zellen, aber es kommen auch solche von 31—33×22—25 μ Zellgrösse vor, die gewissermassen zum *Ph. minutus (= Ph. pleuronectes* var. *minuta)* überführen. Die Abgrenzung dieser Art gegenüber *Ph. orbicularis* scheint mir nicht eindeutig zu sein (Figs. 4, 5).

20. *Phacus pseudonordstedtii* Pochm. — *2* — Mit Stachel 33—36×20—21 μ grosse Zellen. Nach Pochmann (1942) vermittelt diese Art einen Übergang zwischen *Ph. pyrum* und *Ph. nordstedtii.* Körper drehrund, mit zarten Spiralrippen und zwei lateralen Paramylonkörnern (Fig. 17).

21. *Phacus pyrum* (Ehrbg.) Stein — *1* — 38—40×13—16 μ grosse Zellen. Ehl.

22. *Phacus triqueter* (Ehrbg.) Duj. — *2* — 42—46×34—36 μ grosse Zellen, die im optischen Querschnitt dreieckig erscheinen. Die Arten *Ph. pleuronectes* und *Ph. triqueter* scheinen durch Übergänge verbunden zu sein.

23. *Trachelomonas scabra* Playf. — *4, 5, 7* — 21—22×15—15,5 μ grosse Zellen. Ehl.

Unter den aufgezählten Taxa scheint der limnisch—euryhaline Charakter bei folgenden ausgeprägt zu sein = *Euglena acus, Euglena tripteris, Phacus pyrum, Trachelomonas scabra.*

Bei folgenden limnischen Arten ist eine mehr-weniger bemerkbare Neigung zum limnisch-euryhalinen Charakter anzunehmen = *Euglena subehrenbergii, Lepocinclis fusiformis, Phacus inconspicuus, Phacus lemmermannii.*

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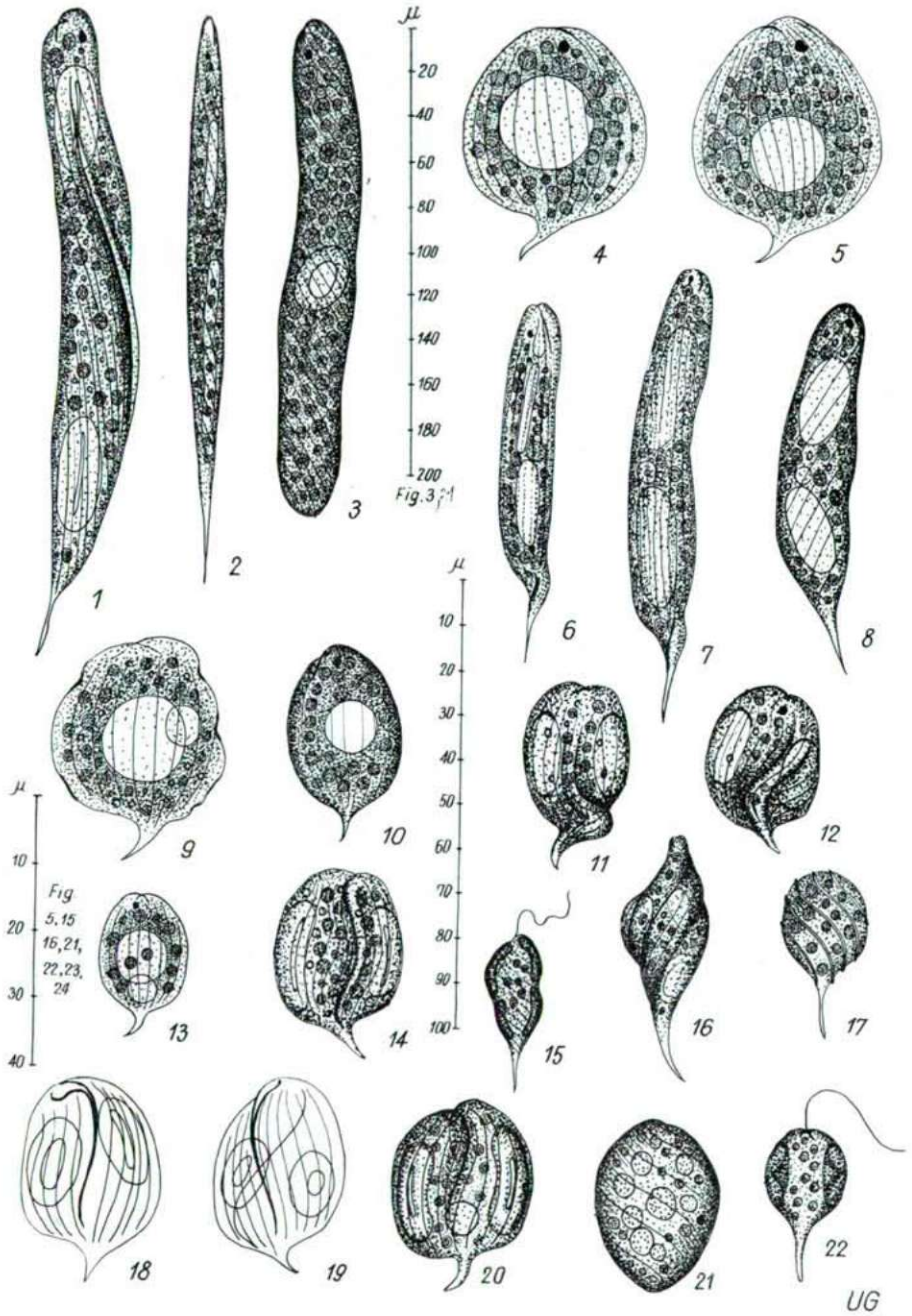
Tafelerklärung

1. Euglena tripteris (Duj.) Klebs. 2. Euglena acus Ehrbg. 3. Euglena subehrenbergii Skuja. 4—5. Phacus pleuronectes (O.F.M.) Duj. 6—7. Phacus allorgei Defl. 8. Euglena limnophila Lemn. 9. Phacus onyx Pochm. 10. Phacus hameli Allorge et Lefév. 11—12. Phacus contortus Bour. 13. Phacus ankylonoton Pochm. 14. Phacus lemmermannii (Swir.) Skvor. 15. Phacus aenigmaticus Drez. 16. Euglena tripteris var. crassa Swir. forma? 17. Phacus pseudonordstedtii Pochm. 18—19. Phacus alatus Klebs. 20. Phacus lemmermannii (Swir.) Skvor. 21. Lepocinclis texta (Duj.) Lemn. 22. Phacus inconspicuus Defl.

TAFEL I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Acta Biologica Szeged *13*, (3—4), pp. 125—132 (1967)

REDUCTION OF THE TONIC EFFECT OF $BaCl_2$ BY DIFFERENT CATIONS IN ISOLATED HEARTS AND SMOOTH-MUSCLE ORGANS OF THE EDIBLE SNAIL (HELIX POMATIA L.)

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(Recived Oktober 31, 1967.)

Introduction

In earlier publications (Erdélyi, 1965) I dealt with the effect of different cations on the functioning of isolated heart of edible snail. Among them I have examined in details, on qualitative and quantitative bases, the effect of $BaCl_2$ on the functioning of heart. (Diagr. 1 and 2 belong to the above mentioned article. See Figs. 2, 3 there, too.) As a result of the performed examinations I have ascertained that the influence exerted by $BaCl_2$ is manifested in an increase of tonicity in direct proportion to the applied dose, till getting to the saturation value. This effect of $BaCl_2$ can be observed, in a way, analogous to the investigation on *Mammalia*, on intestine and fragments of organs of the reproductive system of snail (Minker and Koltai, 1961). It became clear by my further examinations that the antagonists of the effect of $BaCl_2$ in the heart, intestine and penis with flagellum is $CaCl_2$ (Erdélyi, 1968).

Of late, I have examined the efficiency of mono-, di-, and trivalent cations in respect of antagonism. I want to treat of the results obtained, in details, in my present publication.

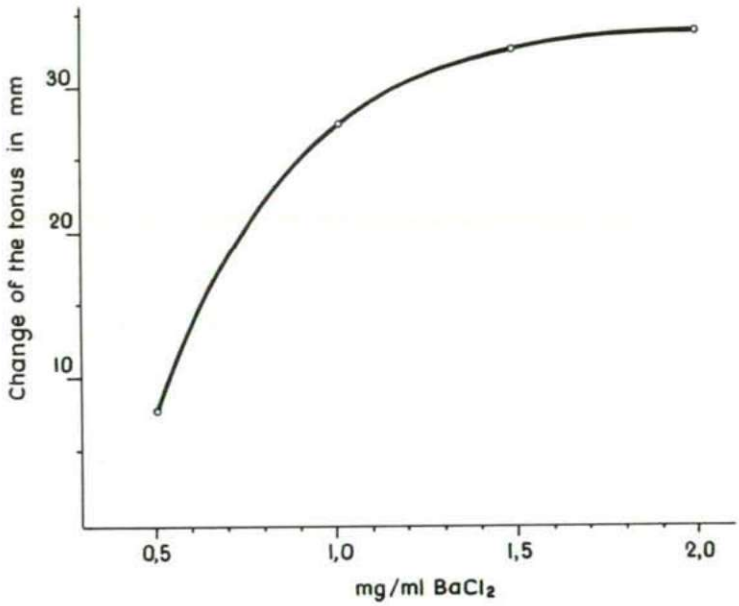
Material and methods

I have examined in a lot of experiments on isolated hearts and fragments of intestine and penis with flagellum of edible snail (*Helix pomatia* L.) how effective the following mono-, di-, and trivalent cations are: Cs^{*}, Li^{*}, NH_4^{**}, Be^{**}, Ca^{**}, Cd^{**}, Co^{**}, Fe^{**}, Mg^{**}, Mn^{**}, Sn^{**}, Sr^{**}, Zn^{**}, Al^{***}, Bi^{***}, Fe^{***}, after the administration of $BaCl_2$. The isolated organs were expanded, at the experiments, in a ten ml. organ-vesel, in *Jullien's Helix-Ringer*. During the experiments I have taken care of airing the organs and the experiments were carried out a standing temperature of 27° C, in summer, resp. in early autumn.

Results and Discussion

The effect of $BaCl_2$ both on heart and intestine, resp. on fragments of organs of the reproductive system is modified in a very various way

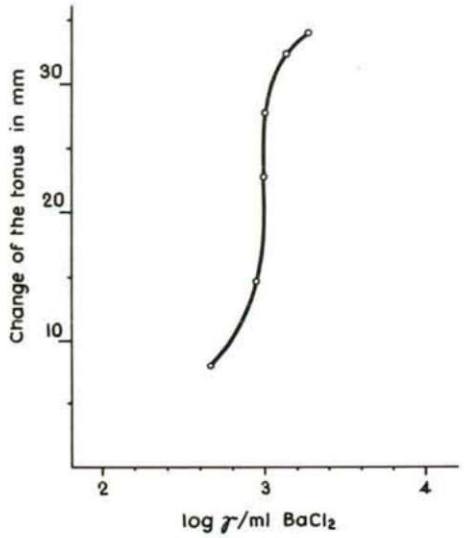
by the examined different mono-, di-, and trivalent cations. The changes of effect are summarized in Table 1. At reading the data of the published Table, it is to be considered that the change of cation effects is defined in relation to the change of function caused by the influence of $BaCl_2$



Diagr. 1. Curve of tonus inxreasing effect of $BaCl_2$

in a concentration of 1 mg/ml. Anyway, only the tonic effect of $BaCl_2$ in a concentration of 1 mg/ml is common in every case of the three organs examined. Other parameters of the organs functioning automatically are modified by $BaCl_2$ in the tonic area in a highly different form. At the heart and penis with flagellum the amplitude of automatic functioning mostly decreases while in case of intestine it rather grows. At heart the frequency is unchanged or a little decreased, at intestine and the fragments of organs of the reproductive system it decreases somewhat, as well. In the Table, the change of effect of the different cations is demonstrated on the basis of the summarized result of an examination of more kinds of doses, and a mean change of tendency, obtained from several experiments, was taken into consideration. In the single experiments, the detailed course of the changes of effects may be valued by the kymogramm.

Considering the above-mentioned facts, it can be read from the data of Table that from the cations examined the most perfect antagonists of $BaCl_2$ is $CaCl_2$. The increased tonicity caused by $BaCl_2$ is compensated completely by $CaCl_2$ both in intestine and in the heart, and in the penis with flagellum, too, it is considerably decreased. Similarly, the change of amplitude and



Diagr. 2. Barium dose effect curve.

TABLE 1. The marks of Table concern the changes following the effect of 1 mg/ml $BaCl_2$ concentration, taking place under the influence of the doses of ions, given in the Table, and being the most optimal in respect of the phenomenon. Cf. the physiological effect of $BaCl_2$ in the text. +: indicates an increasing effect, —: a decreasing one, +—: a changing one, and Ø: an unchanged effect.

Ions	Heart			Intestine			Penis with flagellum		
	Change of the			Change of the			Change of the		
	tonus	frequency	amplitude	tonus	frequency	amplitude	tonus	frequency	amplitude
Cs^+	+	—	+—	+	Ø	+	—	—	+
Li^+	+—	Ø	—	+	+—	+—	—	—	+
NH_4^+	+—	—	+—	+—	—	+—	—	+	+—
Be^{++}	—	—	—	—	+—	+—	—	+	+
Ca^{++}	—	+—	+	—	+—	+	—	+—	+
Cd^{++}	—	—	+—	—	—	—	+—	—	—
Co^{++}	—	—	+	+—	+—	+	—	+	+
Fe^{++}	+—	—	+—	—	—	—	+—	+—	+
Mg^{++}	+	—	Ø	+	Ø	+	+	Ø	+
Mn^{++}	—	—	+	—	—	+	—	—	+
Sn^{++}	—	—	+—	—	—	+	—	—	+
Sr^{++}	+	—	+—	+	Ø	+—	+	Ø	+—
Zn^{++}	+	—	+	—	+—	+—	—	—	+
Al^{+++}	—	—	+	—	+	Ø	—	—	+
Bi^{+++}	+	—	—	—	—	—	—	+	+
Fe^{+++}	+—	—	+—	—	—	—	+—	+—	+

frequency caused by $BaCl_2$ is antagonized in the intestine, heart and penis with flagellum by $CaCl_2$, even if after the formation of a compensatory area, secondarily, an increase of amplitude occurs in case of all the three organs examined, as a result of a joint effect of both ions. The effect of the other cations is characterized by compensating some characteristics of the parameter changes caused by $BaCl_2$ in a form agreeing or disagreeing, in any organs. There are, however, quite a lot of cations which, as to their effects, cannot be considered at all as antagonists of any parameter change of $BaCl_2$. Further on, I will separately deal in details with the effect of the cations examined.

CsCl. CsCl doesn't prevent the development of an increased tonicity caused by $BaCl_2$, either in intestine or in the heart (Plate I. Fig. 1). Opposite to the two organs mentioned above, however, the barium spasm of fragments of organs of the reproductive system is slightly counteracted by it, meanwhile the amplitude of automatic functioning is growing and the frequency decreasing a little. CsCl promotes in the intestine a further increase of the amplitude produced by barium ions the frequency is, however, not essentially influenced by it. In the heart a decrease of frequency takes place as a result of the joint effect of both ions while the amplitudes become unstable in consequence of the periodic change of the force of retractions.

LiCl. LiCl decreases the tonic effect of $BaCl_2$ both in the heart and in penis with flagellum examined, while in the heart a decrease of amplitude appears without any essential change of frequency (negativ inotropic effect). The effect on the fragments of organs of the reproductive system exactly antagonistic, accompanied by a strong increase of amplitude and decrease of frequency. In the intestine, the tonic effect of $BaCl_2$ is increased by LiCl while instabil changes of amplitude and frequency occur.

NH_4Cl. The barium spasm of organs of the reproductive system is somewhat decreased by NH_4Cl while frequency is increased and the amplitude of the automatic functioning along the line of the tonus decrease is unchanged: however, later on major changes occur with infrequent, and minor ones with frequent, amplitudes. The tonus of $BaCl_2$ is decreased by NH_4Cl in the heart, resp. in intestine but in lesser degree and only transitorily (Plate I. Fig. 2). After the part of decreased tonicity, an increase of tonus appears in the heart faster and is the intestine more slowly. At the line of the decreased tonus the amplitude is decreasing, too, both in case of heart and of intestine while the frequency is not changing essentially. In the domain of the increased tonus, similarly, a decrease of frequency ensues analogously in both organs while the amplitude of the automatic functioninng is composed of major components of rare waves and of minor ones of dense waves.

$BeCl_2$. The tonic effect of $BaCl_2$ is an isolated heart is fully antagonized by $BeCl_2$ (Plate I. Fig. 3). Simultaneously with the decrease of tonus, however, a decrease of amplitude and a minor decrease of frequency take place, demonstrating that the Ba^{++}-Be^{++} antagonism concerns only the tonic change of heart functioning. The tonus decreasing effect of $BeCl_2$ appears also in case of penis and of intestine. At both latter organs, however, besides the periodical fluctuation of tonus, finally a

decrease of tonicity prevails. Frequency and amplitude of the automatic function of penis is strongly increasing, as a result of the joint influence of both ions, while at intestines both frequency and amplitude get a changing value and, finally, the effect is stabilized on the level of decrease (Plate II. Fig. 1).

$CdCl_2$. $CdCl_2$ decreases strongly the tonus of isolated heart and fragments of intestine, at the same time increasing that of the penis. Simultaneously with the tonic change, its strongly retarding effect prevails besides the barium ions, as well. In case of the fragments of intestine, it immediately suspends the automatic functioning while in the penis and in the heart the standstill of motion takes place but gradually. In case of the penis the cadmium checking continues decreasing the parameters till the automatic functioning being suspended, while in case of the heart only the frequency decreases strongly at the line of the tonic decrease, the amplitude is initially increasing and the full heart block follows later.

$CoCl_2$. The tonicity of heart and penis with flagellum is strongly decreased by $CoCl_2$ while at intestine there occurs but a decrease of transitory character and the tonus increases, with some rupture, even after $CoCl_2$ having been administered. Es a result of the joint effect of both ions, the amplitude of the cardiac functioning is increasing, its frequency, however, decreasing. The amplitude of the automatic functioning of the isolated fragments of intestine and penis with flagellum is changing, major strong and minor weaker contraction groups follow one another. Frequency is changing, too, in case of both latter organs.

$FeCl_2$ In case of all the three organs examined $FeCl_2$ and $FeCl_3$ have a thoroughly analogous influence. Affected by ferric ions, the barium spasm ceases to some extent. At intestine the solution of tonus is undiminished, at the heart and the penis the initial decreasing tendency rises after some rupture. Influenced by ferric ions, the motion of intestine cease sto function; at the heart, too, the short blocking period appears, followed by returning of the automatic functioning. Then the frequency decreases followed by a weak decrease of amplitude in changing periods. At penis with flagellum a strong increase of amplitude can be observed, as a consequence of ferric ions, followed by a changing frequency.

$MgCl_2$. The tonic effect of barium ions cannot be defended, in case of any organs examined, by $MgCl_2$. The line of the increased tonus continues rising even after the administration of $MgCl_2$. As a result of the joint effect of both ions, the amplitude of cardiac function does not change essentially; the frequency, on the other hand, is decreasing somewhat. In the intestine a strong increase of amplitude is brought about by the magnesium ions; later on, however, it decreases in the state of a rising tonus. The motion of the penis is stimulated by the magnesium ions. Influenced by $MgCl_2$, strong contractions of big waves and those of dense small implitude follow ane another.

$MnCl_2$ The tonicity of the isolated heart of snail is diminished extremely strongly by $MnCl_2$, until reaching the full compensatory level, that of the isolated fragments of intestine and organs of the reproductive system even beyond that (Plate II. Fig. 2). At the line of the

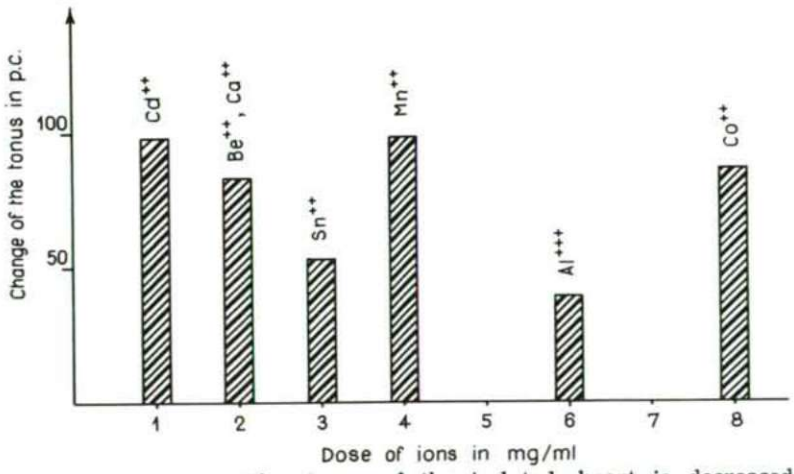
decreased tonicity in case of heart an intensive increase of the amplitude appears and meanwhile the frequency is decreasing in a high degree (positive inotrope and negative chronotrope effect). In the intestine lesser dense and major more rarely repeated waves follow one another with somewhat smaller frequency, compared with the effects of barium ions (Plate II. Fig. 3). On the fragments of organs of the reproductive system, similarly to the heart, a strong increase of amplitude takes place followed by a very intensive increase of frequency. Later on, the frequency becomes also here slower at the line of the tonic decrease.

$SnCl_2$. Influenced by $SnCl_2$, the tonicity of all the three isolated organs is decreasing a little while other parameters of the automatic functioning gradually decrease.

$Sr(NO_3)2$. Stroncium ions, similarly to the magnesium ions, result in a further increase of tonus. The amplitude of the automatic functioning is, in case of all the three organs, of changing strength, the frequency at heart is decreasing a little, in case of the two other organs it is, however, unchanged.

$ZnCl_2$. The tonicity of intestine and of the penis are decreased while that of heart is raised by $ZnCl_2$. Influenced by zinc ions, the amplitude of cardiac functioning is growing (positive inotrop effect), while its frequency decreasing (negative chronotrope effect). In the intestines there can initially be observed strong changes of large amplitude and of decreasing frequency, later continued by motions of quick frequency and small amplitude. The amplitude of penis is increasing under the influence of $ZnCl_2$ while its frequency is decreasing.

$AlCl_3$. Under the influence of $AlCl_3$ the tonicity of all the three isolated organs (heart, intestine, penis) decreases a little. The degree of tonic change and the connection with the dose are shown related to the



Diagr. 3. *Helix:* heart. The tonus of the isolated heart is decreased by the different doses of the different cations in a changing degree. The tonus-increasing effect of 1 mg/ml $BaCl_2$ concentration is 100 per cent.

heart at the most important tonus-reducing ions in Diagr. 3. Simultaneously with the decrease of tonicity a decrease of amplitude and frequency takes place in the heart. In case of intestine there is no major change in amplitude; the frequency, however, is decreasing a little.

$BiCl_3$. Affected by bismuth ions, the tonus of heart continues rising; on the other hand, that of intestine and of penis is somewhat decreasing. $BiCl_3$ has a strongly retarding effect on the functioning of heart and intestine while the motion of the penis is strongly stimulated by it.

Summary

The effect of the examined cations against $BaCl_2$ can be summarized as follows:

1. In case of the heart, the tonus-increasing effect of $BaCl_2$ is influenced by the different cations examined in different ways which can be divided into three main groups.

a) In very different doses (in concentration of 1—8 mg/ml after 1 mg/ml $BaCl_2$) the tonus is decreased by cations: Ca^{**}, Be^{**}, Cd^{**}, Co^{**}, Mn^{**}, Sn^{**}, Al^{***}.

b) The tonus is unchanged or increasing under the influence of cations Cs^{*}, Mg^{**}, Sr^{**}, Zn^{**}, Bi^{***}.

c) Finally, the tonus is showing a significant variation, initially it is decreasing, later on, however, increasing under the influence of cations Li^{*}, NH_4^{*}, Fe^{**}, ***.

2. The barium spasm of smooth-muscles of the intestine and penis is decreased, just as in case of heart, by Ca^{**}, Be^{**}, Mn^{**}, Sn^{**}, and Al^{***}.

On the other hand, Sr^{**}, and Mg^{**} are, in the latter case too, synergists of $BaCl_2$.

3. Amplitude and frequency change in case of all the three organs in a highly different form, both in the direction of increase and decrease, but they cannot be connected with the influence of the given ion on tonicity.

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Minker, E. and Koltai, M. (1961): Untersuchungen an isolierten Gastropodenorganen. Acta Biol. Acad. Sci. Hung. *12*, 199—209.

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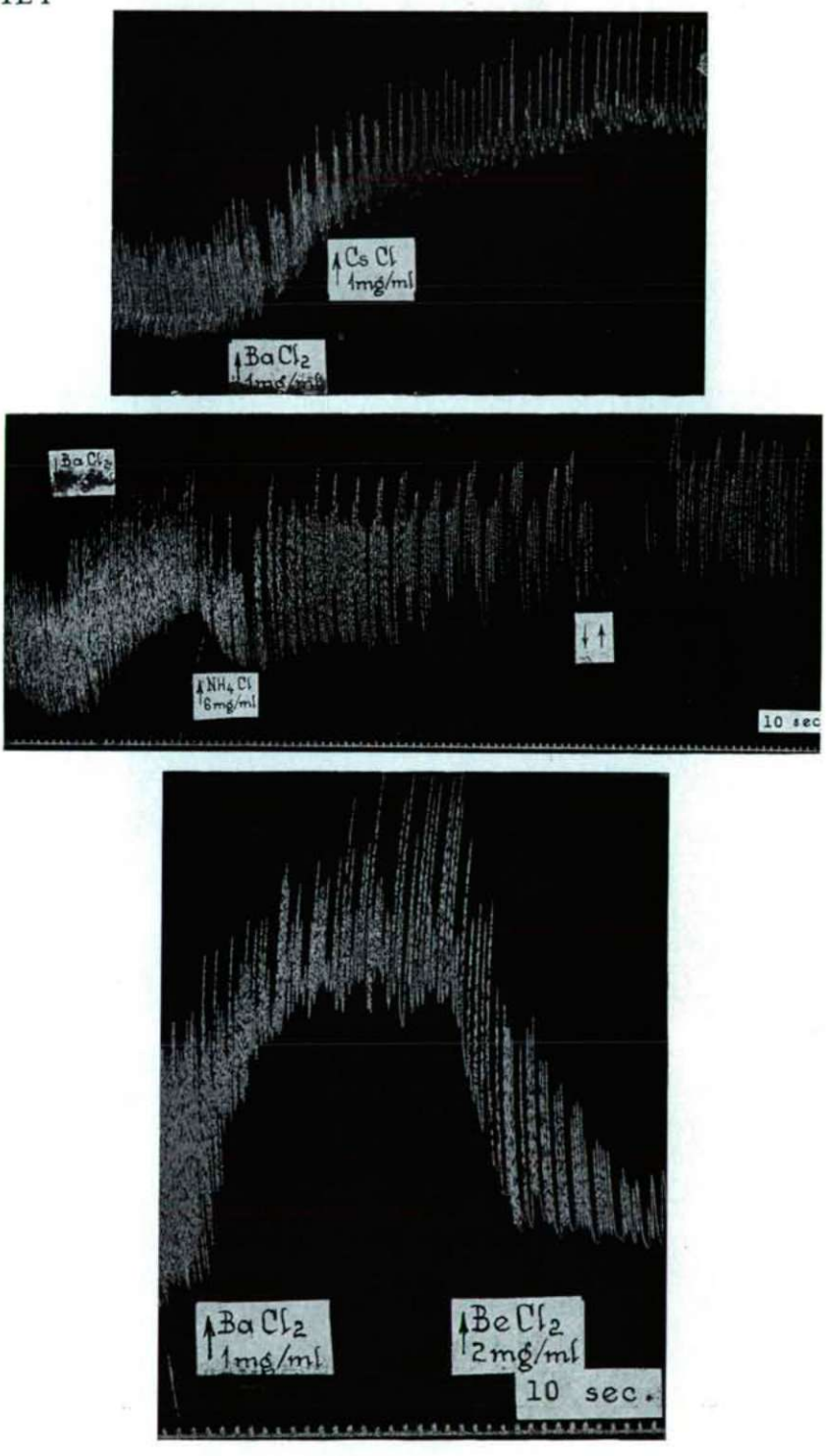
Plate I. *Helix:* heart. Under the influence of cesium ions, the tonus-increase elicited by $BaCl_2$ has remained, the frequency decreased, and the amplitude nicreased a little.
Helix: heart. Under the influence of NH_4Cl, the tonus initially shows a decreasing tendency then it again rises. Meanwhile the amplitude of automatic functioning is increasing and its frequency decreasing.
Helix: heart. Under the influence of berillium, the barium spasm is thoroughly counteracted. This change, however, leads to a strong decrease of amplitude.

Plate II. *Helix:* penis with flagellum. The berillium and barium ions, acting together, stimulate strongly the automatism of penis.
Helix: heart. Under the influence of Mn^{++}, the barium spasm is counteracted, but the joint effect of both ions is accompanied by a strong decrease of frequency and an increase of amplitude.
Helix: intestine. The strong decrease of tonicity, influenced by Mn^{++} is obvious, as well as the stimulation of automatic peristalses.

PLATE I


Cs Cl
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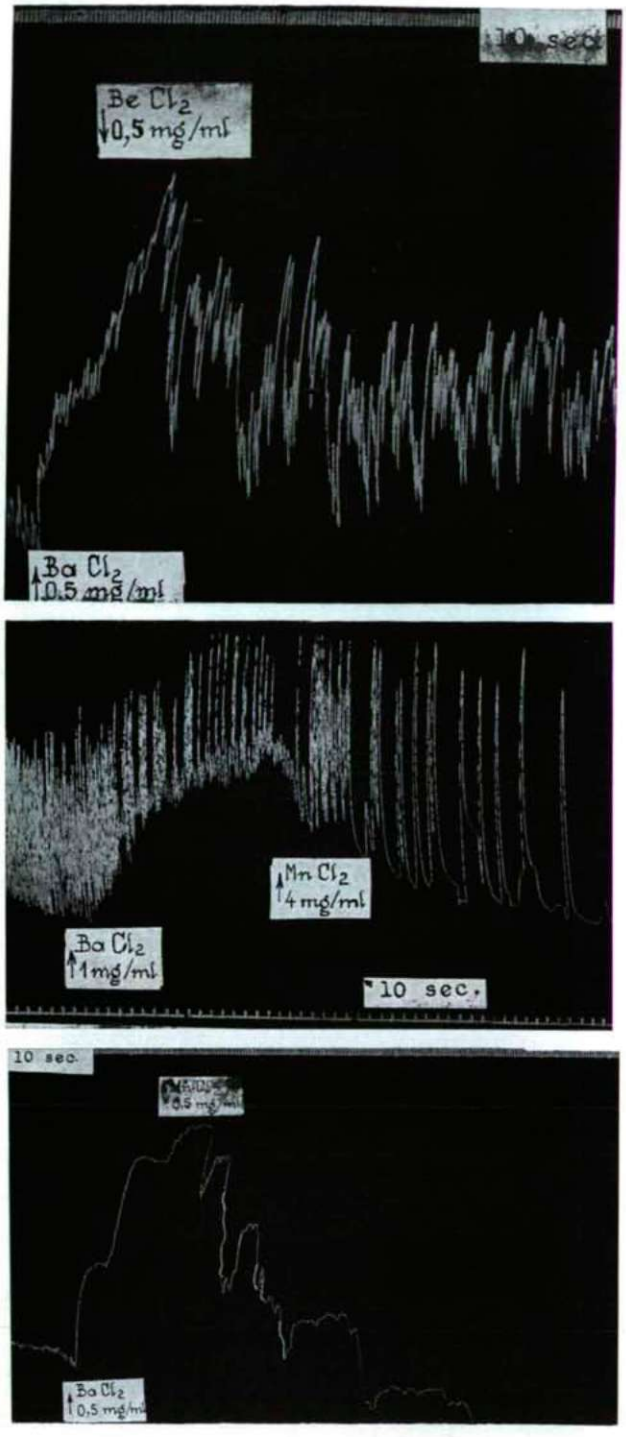
NH4 Cl
6mg/ml
10 sec
Ba Cl2
1mg/ml
Be Cl2
2mg/ml
10 sec.

PLATE II


10 sec.
Be Cl2
0,5 mg/ml
Ba Cl2
0.5 mg/ml
Mn Cl2
4 mg/ml
Ba Cl2
1 mg/ml
10 sec.
10 sec.
Ba Cl2
0,5 mg/ml

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THE FOSSIL HOLOCENE MOLLUSCA FAUNA OF THE LAKE AT KARDOSKÚT AND ENVIRONS

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(Received October 31, 1967)

On more occasions I have paid visits to the lake at Kardoskút in the neighbourhood of Orosháza, like a member of the cooperative researching the salt waters of the Hungarian Plain. The highly salt water of the lake is grey, containing much floating mud. It is large but shallow, fordable in every period of the year and completely drying up in summer. Its bottom is of boggy mud without any floriferous water plant in it. Also the lake-side is bare, bordered by low grass.

In the water there were but a few specimens of *Anisus spirorbis* L. alive. This stout ubiquitous species endures well the water of strongly alkali reaction and its periodical drying up, as well. Nevertheless, in the water of lake it only vegetates, perhaps because of a lack in food and the whirling of mud. At the shore there vegetated some *Succinea oblonga* Drap. In the vicinity of the lake there lived some *Pupilla muscorum* L. and *Imparietula tridens* O. F. Müller in the grass, in low individual number. A mass of fossil species are thrown out here and there to the lake-side by the waves, those can be found en masse on the bottom of the lake, as well, after it having been dried up. They are evidences for the rule of thoroughly different living conditions much more favourable from the point of view of the molluscs here erstwhile. Analysing that fossil fauna I have got the following results.

Water fauna. Number of species: 19. *Valvata pulchella* Studer. It seems to die out already in the Hungarian Plain to-day, north of us, however, it is still a frequent species. Its individual number is high, remembering the loess fauna. *Valvata cristata* O. F. Müller. Its individual number is high. In the rather clear stagnant waters of the Plain with water vegetation it is, even to-day, similarly frequent here and there. The frequency of *Bithynia leachi* Sheppard, besides the lack in *Bithynia tentaculata* L., remembering us similarly of the pleistocene conditions. In the Plain the *tentaculata* is dominant at present, while the *leachi* is spread much less. *Stagnicola palustris* O. F. Müller feels here similarly well as at present, too, in our marshy stagnant waters. Also the individual number of the f. *corvus* Gmelin and f. *turricula* Held is high. The quantity of *Galba truncatula* O. F. Müller is large. Its occurrence in our Plain in that quantity is frequent in pleistocene

but it is rare in a recent form. The individual number of the recent common *Planorbis corneus* L. is moderate, represented by individuals of small stature, in the loess fauna we have had a similar experience. The quantity of *Tropidiscus planorbis* L. is similarly high, as it is at present, too, in a lot of our standing waters. The individual number of *Spiralina vortex* L. is low, in a lot of places, in loess, and as a recent one, too, it is more frequent than here. *Anisus spirorbis* L. is similarly frequent as it is in the present. *Anisus septemgyratus* E. A. Bielz. It is frequent enough. Its origin is in Eastern Europe, it is a somewhat thermophilous species. I have observed its occurrence in a similar quantity in the loess of the milder glacials and in our stagnant waters, as well. *Anisus leucostoma* Millet. It is rather frequent, remembering more the loess than the present conditions. The quantity of *Bathyomphalus contortus* L. is considerable, in our Plain its occurrence in such a large mass in loess is more frequent, than at present. The quantity of *Gyraulus albus* O. F. Müller is very small, at present it is spread and frequent. *Gyraulus laevis* Alder. It is frequent enough. This species is frequent in loess of the Plain, while we have hardly any data about its recent occurrence here. The individual number of *Armiger crista* L. and *Segmentina nitida* O. F. Müller is low, it is more seldom in loess with us than similar recent ones. The quantity of *Pisidium obtusale* C. Pfeiffer and *Pisidium cinereum* Alder is comparatively small, they are here and there in the loess, and as recent ones as well, more frequent. *Dreissena polymorpha* Pallas. A fragment from top of a juvenile specimen. It is known from the pliocene sediments in this country, in the pleistocene, however, none of them has been found here, as yet. Its homes were originally the rivers flowing into the Caspian Sea and Black Sea, in Europe it has spread since the beginning of the last century by the ship traffic. Its occurrence at Kardoskút, must, anyhow, be still older. The species is dwelling in lakes, as well, where it has supposedly got with the mud, stuck to the feet of the water birds. Also here it may have arrived from the river Maros.

On the basis of the fauna described above, the lake used to be of standing character, cool water, neutral reaction, rich in water plants and of good oxygen supply. Considering the present conditions of the Hungarian Plain, the fauna is more similar to the population of loess of the mild glacial, without verifying the glacial. The fauna, surviving the glacial, influenced by the milder climate and not troubled, as yet, by human influences, has proliferated in an area suitable for that. Also this water may have been like that.

Riparian species. Number of species: 3. *Carychium minimum* Risso. Few. *Succinea oblonga* Drap. Its quantity is very high. In the loess it is frequent, and along our Plain salt lakes it is alive in a high number at present, too. *Succinea pfeifferi* Rm. Its individual number is high. In the Plain in loess, too, and also at present, it is frequent. It is very sensitive to be shrivelled. It is found on the part of water plants above the surface of the water, and in the shade of the riparian vegetation. Accordingly, the lake-shore was not so bare as it is at present. **Hygrophilic ubiquitous species.** Number of species: 13.

Cochlicopa lubrica O. F. Müller. Rather many. *Vertigo pygmaea* Drap. Rather many. *Vertigo antivertigo* Drap. Rather many. *Truncatellina cylindrica* Fér. Very few. *Pupilla muscorum* L. A great many. *Vallonia pulchella* O. F. Müller. Many. *Vallonia enniensis* Gredler. Few. *Vallonia costata* O. F. Müller. Very few. *Zonitoides nitidus* O. F. Müller. Few. *Vitrea crystallina* O. F. Müller. Rather many. *Euconulus trochiformis* Montagu. Rather many. *Zenobiella rubiginosa* A. Schmidt. A lot. *Trichia hispida* L. Few. All these species occur in the loess, as well, and they are alive along our Plain waters at present, too, where they find enough shade in the riparian vegetation against insolation, and the air is supplied with due vapour content by the nearby water. The quantitative distribution of species is highly influenced by the micro-climate. The environment may have been humid, unfavourable from the point of view of *Truncatellina cylindrica* Fér. Among the three *Vallonia* species, the hygrophilic *V. pulchella* is very frequent, the more xerophilic *V. enniensis* is fewer, the still more xerophilic *V. costata* has the lowest number of individuals. The great quantity of the *Zenobiella rubiginosa* that is rare in loess, makes the population holocene in character.

Grove-dwellers. Number of species: 3. The occurrence of the *Vertigo substriata* Jeffreys is sporadic. It is a North-Alpine species in a broader sense. In Hungary there was found only one recent specimen of it (Nagyhideghegy, Börzsöny mountain). From the Hungarian pleistocene there are only two data concerning the finding site of it (Királyhalom in the neighbourhood of Szeged and Nagykőrös. Rotrides' s data). Its occurrence in the Plain holocene is remarkable. *Perpolita hammonis* Ström. In Hungary it is at present mainly a mountain species, its Plain occurrences (Ócsa, Bátorliget) have rather a character of relicts. In the pleistocene it is frequent. It seems to have been erstwhile in the Plain in holocene much more scattered than at present.

Perforatella bidens Chemnitz. Sporadic. On the Hungarian Plain it is considered as a pleistocene relict. It is known in the moore of Bátorliget, author collected it in mass at the mouth of the river Szamos (Sárkánykert). In the loess it is rather frequent. It has a considerable demand on humidity. On the basis of the three species we need not suppose any wood or grove, they do survive in humid meadows, too. *Perpolita hammonis* is pleased to dwell in *Betuletum*, *Perforatella bidens* is in *Alnetum* often found whose occurrence is possible at the lake.
Thermophilic fauna. Number of species: 4. *Abida frumentum* Drap., *Imparietula tridens* O. F. Müller, *Helicella hungarica* Soós et H. Wagner, *Cepaea vindobonensis* C. Pfeiffer. The number of the individuals of all the four species is very high. Although they occur in loess, but on the basis of such a quantity of theirs only a holocene climate can be supposed any more. The occurrence en masse of the *Cepaea vindobonensis* C. Pfeiffer, which is very rare in loess, is particularly obvious. Besides its accustomed specimens of dark ribbons, there occur different ribbon variations of it, also the f. *pallescens* Fér. with pale ribbons is frequent. The species likes the warm environment with half-shade that may have been in the drier bushy environment of

the lake-side. That environment also the other thermophilic species fit into. The lack of *Helicella obvia* Hartmann is obvious, at present this species is the most frequent thermophilic snail of the Plain, dwelling, however, only in open sunlit places.

The number of the species collected is 42. According to the above-discussed data, they are the fossilized members of a mollusc population from the holocene period. The lake and its environment, and accordingly also its fauna, are over a succession process. We have recognized two stages of that process, an old one from the holocene period and the present one. Each stagnant water of the Plain has a history of succession the recognition of whitch is only possible with a simultaneous investigation of the fossil and recent fauna.

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DATA ABOUT THE MOLLUSCS OF ADRIA

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The data presented in this paper were collected by K. Báb a, according to the points of view of a previous discussion with A. Horváth, in August 1966. Our purpose was to study the qualitative and quantitative division of molluscs in the littoral biotopes. The collection has taken place in two ways. (A) Cenological collection, collecting every specimen in a square area of definite size. (B) Individual collection, collecting the molluscs found during perambulating a larger area. The results of these collections are made known one by one, as follows. The numbers, written after the Latin names of species, are meaning the number of the found specimens, after them it is indicated in brackets, as well, how many of them were juvenile specimens.

Cenological collections

Rocky bay, 1 km from the village Grljévac-Postrana, extension about 1—1.5 km.

(1) August 16th. Muddy bottom in front of the camping ground, about 20 m from the coast, from a depth of 1—2 m, among algae *Posidonia oceanica* L., on a surface of 1 sq.m. On the bottom there were *Loripes lacteus* (L.) 11 (8 juv.) and *Gafrarium minimum* (Mont.) 1. On the alga: *Calliostoma zizyphinus* (L.) 1. In some more square metres, examined for control, there were *Loripes lacteus* (L.) 3—7 and *Cerithium vulgatum* Brug. 2—3, per sq. metres.

Near the coast there were on the alga *Ulva lactuca* L.: *Rissoa variabilis* (v. Mühlfeld) 2.

Dominant species is: *Loripes lacteus* (L.).

(2) August 17th. Distance from the coast is 5—10 m, depth 3 m, the substratum is sandly, vegetation: *Posidonia oceanica* L. From 1 square metre we have got the following seven species. *Loripes lacteus* (L.) 8, *Codokia reticulata* (Poli) 1, *Venus verrucosa* L. 1, *Venus gallina* L. 1 empty shell, *Venerupis aureus* (Gmelin) 2 juv., *Abra alba* (Wood) 3 empty shells (2 juv.), *Donacilla corneum* (Poli) 1 empty shell.

Dominant species is, also here, *Loripes lacteus* (L.).

(3) August 17th. Distance from coast 3—5 m, depth 1.5 m, rock mass, vegetation: red algae *Sphaerococcus* and *Pterocladia*. Size of sample is 25×25 sq. cm. Number of species collected: 13. *Calliostoma zizyphinus*

(L.) 7 (2 juv.), *Gibbula adansoni* (P a y r.) 33 (9 juv.), *Leptothyra sanguinea* (L.) 2, *Tricolia speciosa* (v. M ü h l f e l d) 1 juv., *Rissoa variabilis* (v. M ü h l f e l d) 32 (11 juv.), *Zippora membranacea* (J. A d a m s) 1, *Cerithium vugatum* B r u g. 1 worn empty shell, *Muricidea blainvillei* (P a y r.) 4, *Columbella rustica* (L.) 3, *Pisania maculosa* 5 (1 juv.), *Nassa incrassata* (M ü l l e r) 2, *Mitra ebenus* L a m. 1, *Facelina drummondi* (T h o m p s o n) 2.

Dominants are *Gibbula adansoni* (P a y r.) and *Rissoa variabilis* (v. M ü h l f e l d). There are more of both of them than of the other eleven species together.

(4) August 18th. In the middle of the bay, or so, about 500 m from the coast, there is a rock mass rising out at low water. Its diameter is 7—10 m. In the rock part below the low water mark until the depth of 1 m from the level of low tide, on the bare surface of rock (without macroscopic vegetation) the results of two samples from 1 sq. m are as follows. *Haliotis lamellosa* L a m. 3 (2 juv.), *Diodora italica* (D e f r a n c e) 2—4, *Patella coerulea* L. 8—11, *Patella scutellaris* L a m. 8—10, *Patella lusitanica* G m e l i n 13, *Gibbula divaricata* (L.) 1—2, *Monodonta turbinata* B o r n 13 (5 juv.), *Vermetus arenarius* (L.) 4—6, *Cerithium vulgatum* B r u g. 1—3, *Natica millepunctata* L a m. 1, 0.5 m deep, from a depth of 1.5—2 m some more specimens, too, have been found. *Cypraea spurca* L. 1, *Murex trunculus* L. 1—1 juv., *Tritonalia erinacea* (L.) 1—1, *Columbella rustica* (L.) 2—3, *Pisania maculosa* L a m. 2—3, *Fusus syracusanus* (L.) 1—2, *Conus mediterraneus* B r u g. 3—5, *Lithophaga lithophaga* (L.) en masse, *Ischnochiton rissoi* (P a y r.) 3, *Chiton olivaceus* S p e n g l e r 3—5.

Dominant species is *Lithophaga lithophaga* (L.) Number of species 21.

(5) August 18th. Island opposite to the bay of Grljévac-Postrana, about 3 km from it. Sandy bottom in front of the concrete mole, depth is 8—10 m. Per square metres: *Cerithium vulgatum* B r u g. 3—10 and *Pinna nobilis* L. 1—3. On one of the developed *Pinna nobilis* L. specimens the following eight specimens have been stuck: *Vermetus arenarius* (L.) 15, *Vermetus triqueter* B i v o n a 5, *Arca lactea* L. 1 juv., *Chlamys pusio* L. 1, *Lima lima* (L.) 1, *Chama gryphoides* L. 3 (2 juv.), *Cardium papillosum* P o l i 1, *Saxicava arctica* (L.) 9, (6 juv.).

Dominants are the *Vermetus* species and *Saxicava arctica* (L.).

On the concrete molo, in a depth of 3 metres, there stuck 5 juvenile specimens of *Modiolus adriaticus* (L a m.).

(6) August 19th. Trogir. Part of the concrete littoral of the town, at the bridge, depth 3 metres. On the *Vermetus arenarius* (L.), stuck to the side of concrete, there stuck the *Bryozoa Tubicellaria cereoides.* Its height was 30 cm, diameter 50 cm, and the following molluscs were living on it: *Bittium reticulatum* D a C o s t a 5 (2 juv.), *Nassa incrassata* (M ü l l e r) 4, *Mytilus galloprovincialis* L a m. 25 (10 juv.), *Chlamys varius* (L.) 7 (4 juv.), one of the seven specimens, a juvenile one, was redish, the colour of the other specimens, however, was greyish blue.

Chlamys pusio L. 3 juv., of redish colour. *Pecten maximus* (L.) 1 juv., *Spondylus gaederopus* L. 1, *Ostrea edulis* L.: two specimens of 5 cm.

Dominant was *Mytilus galloprovincialis* L a m.

(7) From the 0.5 m deep underwater zone of the concrete sea wall till its 0.5 m high overwater zone, still under the influence of surf, in an area of 1 square metre there have lived the following species. *Monodonta turbinata* (B o r n) 15 (10 juv.), *Littorina neritoides* (L.) 30 (8 juv.), *Bittium reticulatum* D a C o s t a 8 (2 juv.), *Columbella rustica* (L.) 8 (3 juv.).

Dominant was *Littorina neritoides* (L.), retired into the crevices of concrete, familiar both under and over the water level.

Individual collections

The site of the individual collections was the bay by Grljévac -Postrana, where the cenological collections Nos. 1—4, as well, have taken place. The results are made known in the following, arranged according to depth, referring to the number of specimens and the environment.

In a depth of 0.5—1 m.

25 species. *Ischnochiton rissoi* (P a y r.) 3, *Middendorfia caprearum* S c a c c h i 1, *Chiton olivaceus* S p e n g l e r 5 (4 juv.), in 0.5 m deep, scattered on bare rocks. *Haliotis lamellosa* L a m. 1 juv., on a bare rock 1 m deep. *Diodora italica* (D e f r a n c e) 3, 0—0.5 m deep. *Diodora graeca* (L.) 1. *Patella coerulea* L. 20. *Patella scutellaris* L a m. 19. *Patella lusitanica* G m e l i n 1. *Calliostoma zizyphinus* (L.) by water surface 1, it is common about 1 m deep, occurring here and there in groups. On vegetation. *Gibbula divaricata* (L.) 16 (12 juv.) stuck on rocks. *Gibbula varia* (L.) 4 (3 juv.), on rocks and under stones. *Monodonta turbinata* (B o r n) on rocks, en masse. *Monodonta articulata* (L m.) 1, *Clanculus cruciatus* (L.) 1, on a rock, *Littorina neritoides* (L.) common on littoral cliffs. *Alvania cimex* (L). 1, on vegetation. *Rissoa variabilis* (v. M ü h l f e l d) are common 0.5—1 m deep, among vegetation. *Cerithium vulgatum* B r u g. under stones, sporadically. The species *Columbella rustica* (L.) and *Pisania maculosa* (L a m.) on rocks, stones sporadically. *Cythara taeniata* (D e s h a y e s) 1, under a stone. *Philbertia purpurea* (M o n t a g u) 1, under a stone. *Conus mediterraneus* B r u g. On rocks and stones scattered. *Lithophaga lithophaga* (L.), pierced into rocks, en masse. *Pecten jacobaeus* L., 1 broken, empty shell, cast ashore. *Venus verrucosa* L. 1 juv., under a stone.

In a depth of 1—3 m.

Diodora graeca (L.) 1 ,2 m deep on a rock. *Patella coerulea* L., on a rock. *Calliostoma zizyphinus* (L.), on a rock. In a depth of 1.5 m, on vegetation there were the following four species: *Gibbula adansoni* (P a y r.) 1, *Gibbula divaricata* (L.) 1, *Gibbula adriatica* (P h i l i p p i) 1, *Gibbula varia* (L.) and *Monodonta turbinata* (B o r n) on a rock. *Vermetus arenarius* (L.) and *Vermetus triqueter* B i v o n a normally occur on rocks, till a depth of 10 metres, with 1—5 specimen numbers per a square metre. *Bittium reticulatum* D a C o s t a 2 juv., under stones. *Cerithium vulgatum* B r u g. among stones. *Cerithium rupestre* R i s s o 9 (3 juv.),

in a depth of 2—3 m, on stones and under them. *Murex brandaris* L. 2 juv. *Muricidea blainvillei* (P a y r.) 18 (10 juv.) under stones. *Tritonalia erinacea* (L.) 6 (4 juv.), between 1—8 m, sporadically. *Columbella rustica* (L.), among vegetation, scattered. *Euthria cornea* (L.) 2 (1 juv.) on stones. *Pisania maculosa* (L a m.) on stones, scattered. *Nassa mutabilis* (L.) 1, on a rock, 2 m deep. *Fasciolaria tarentina* L a m. 1 empty shell, on a stone, 3 m deep. *Fusus syracusanus* (L.) 2 (1 juv.), on stones, between 2—3 metres. *Mitra ebenus* L a m. 1, under a stone 1.5 m deep. *Conus mediterraneus* B r u g. under stones, scattered. *Arca barbata* L. 2 (1 juv.) in the crevices of cliffs. *Lithophaga lithophaga* (L.) pierced into rocks en masse. *Spondylus gaederopus* L. 1, among rocks. *Lima inflata* (C h e m n i t z) 1 empty shell, its size was 2.5 cm. *Anomia ephippium* L. 1 juv., under a stone. *Codokia reticulata* (P o l i) 3, in the sand drifted among cliffs, 1.5 m deep. *Cardium exiguum* G m e l i n 2 empty shells among the cliffs in sand. *Venus multilamella* L a m. 1 juv. empty shell, 2 m deep, under a stone. *Venerupis decussata* (L.) 4 (2 juv.) under stones, *Venerupis aureus* (G m e l i n) 3 (2 juv.), under stones, *Gastrana fragilis* (L.) 2, among algae, 3 m deep. *Sepia officinalis* L. 1, in a crevice of rock, 2 m deep. Three nodules of this species have been found among plants, in a depth of 1.5 metres.

In a depth of 3—10 m.

Astraea rugosa (L.) 1. *Vermetus arenarius* (L.), *Vermetus triqueter* B i v o n a, *Cerithium vulgatum* B r u g., *Murex brandaris* L., *Tritonalia erinacea* (L.), *Columbella rustica* (L.), *Lithophaga lithophaga* (L.). From sponges *Ircinia*, in a depth of three metres, 2—3 *Saxicava arctica* (L.) have occurred on the average in a sponge. Similarly in a depth of three metres, in a sponge *Cacospongia scalaris* there were two species: *Chlamys varius* (L.) 1, and *Saxicava arctica* (L.) 2.

Summary

Number of the collected species is 78 together, from that *Amphineura* 3, *Gastropoda* 44, *Bivalvia* 30, *Cephalopoda* 1. From the investigated biotopes there will doubtlessly be found other more species, as well, our fauna list is, therefore, not complete but it is already detailed. The thorough examination is evidenced, anyhow, by resulting in rare species, as well: *Leptothyra sanguinea* (L), *Fasciolaria tarentina* L a m., *Gafrarium minimum* (M o n t.).

Into the cenological sample, few in number and small in size, there could get only a small part of species having but a subordinated role in the biotope, besides the dominant species. The differences of the fauna according to biotopes are demonstrated yet well by these samples. It is obvious, how rich the 25×25 sq. cm sample was from a rock overgrown with red algae (13 species), in contradiction to the greater part of the sq. m samples. The living conditions here have been more favourable the rocky shoal of the bay (No. 4) has produced the most species (21 species) among the cenological samples. An explanation of that may be that it is surrounded already by a rather open sea. The individual collections have resulted in a greater number of species than the cenologi-

cal samples because the investigated area was larger. From the results there could be drawn more other inferences, as well, it is, however, better instead of conjectures to wait for the results of further investigations.

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KONSTITUTIONSSTUDIEN ÜBER BALANUS IMPROVISUS DARWIN II.

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(Eigegangen am 4. Mai 1967.)

Einleitung

Im Oktober des Jahres 1966 hatte ich mit meiner Frau entlang den Küstenpartien des Schwarzen Meeres von Mamaia bis Eforie Sud 12.847 Exemplare von *Balanus improvisus* Darwin gesammelt. Ein kleines Material bekam ich vom Herrn Kollegen Dr. Géza Müller in Konstanza (aus dem Razelm-Teich mit Brackwasser von 0.87 0/00 Salzgehalt).

Die von mir und meiner Frau gesammelten Balaniden-Exemplare sassen grösstenteils auf *Mytilus e. galloprovincialis* und *Aloidis*, seltener auf Krebsen, kleinen Gastropoden und Lamellibranchiaten, sowie auf ins Meerwasser gefallenen *Zea mays*-Stengeln.

Die wissenschaftliche Zielsetzung hierbei war: Fortsetzung meiner Variationsstudien, um die Verhältnisse der Konstitutionstypen und die Wirkungen der Umgbebungs- und Ansiedlungsverhältnisse als eine Komplexerscheinung zu erklären zu versuchen, bzw. die Verhältnisse des Balanidengehäuse-Orifiziums und der Basis-Relation feststellen zu können. Es wird nur die Breite der Basis und die Grösse des Orifiziums als wichtig erachtet, da die Mauerkronelamellen sich nur durch die Umgebungsverhältnisse modifizieren lassen. Die Figuren 1 und 2 stellen diejenigen Prinzipien dar, die hinsichtlich der Kenntnis der Typenverschiedenheiten und Deformationen wichtig sind (Fig. 2).

Das eingeholte Material ist den Sammlungen des Zoosytematischen Institutes der Universität Szeged in Ungarn eingeordnet und teils in Alkohol, teils trocken konserviert.

Die gesammelten Balanidenexemplare haben normale Grösse. Eine Zwergen-Population wie im Baltikum kommt hier nicht überall im allgemeinen in Betracht und ist nicht beständig zu konstatieren. — Hauptassoziationsglieder sind im Meerwasser die Membraniporen (s. auch bei 3) und im Razelm-Teich auf *Phragmites communis* die Plumatellen. Mehrere Exemplare auf kleinen Mollusken und auf *Filophora* sind gekrümmt mit Trichtergestalt (Fig. 3).

Hinsichtlich der typologischen Nomenklatur sei auf meine frühere Arbeit (Kolosváry, 1966) hingewiesen (Fig. 1).

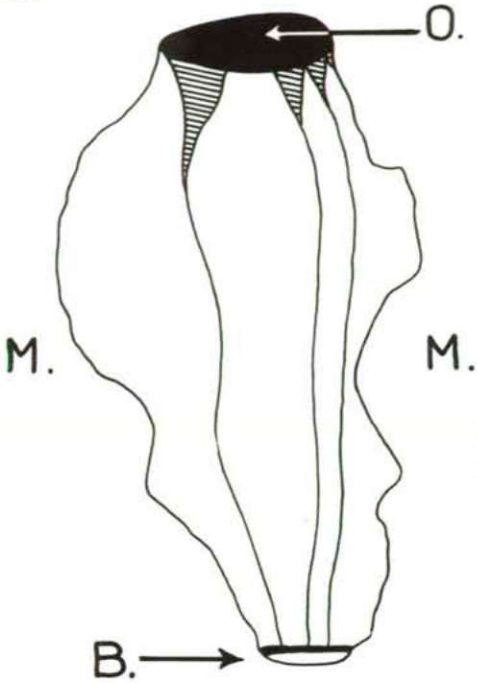
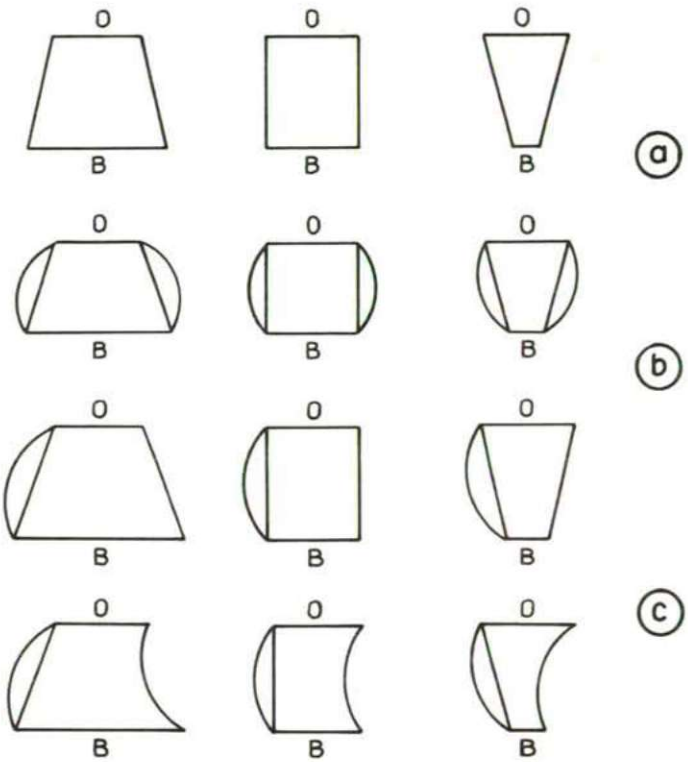


Fig. 1. Mauerkrone
O: Orifizium
M : Mitte des Gehäuses von äusseren Umständen modifiziert d.h. deformiert
B : Basis

Fig. 2. Schemen der Typen
(B : Basis; O : Orifizium)
a : normal-Gestalten
b : Konturdeformationen
c : unilaterale Deformationen



Für die liebenswürdigen Hilfeleistungen sage ich meinen rumänischen Freunden und Kollegen, und zwar Herrn Prof. Dr. P. Borcea und Dr. G. Müller (Konstanza), Herrn Dir. Dr. J. Andriescu (Agigea), Herrn Dr. J. Fuhn und Frau Stefania Avram (Bukarest) und endlich meinem Freunde M. Serban (Klausenburg) meinen verbindlichen Dank.

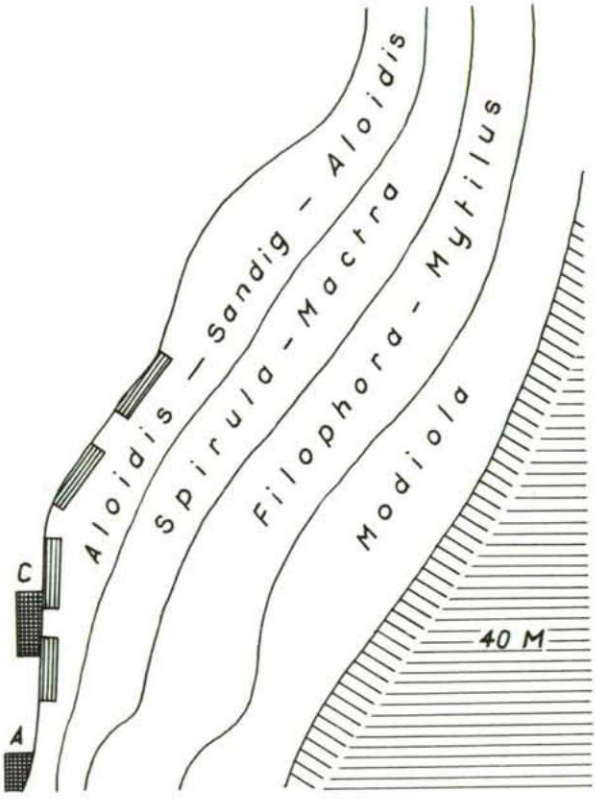


Fig. 3. Uferpartie-Skizze mit Ökotypen

Fig. 4. Trichterkümmerformen auf *Filophora* und *Cardium*

Fundstellen und Ansiedlungsverhältnisse

Schon and Hand von 1000 Exemplaren konnte ich feststellen, dass bzgl. der Ansiedlungsoberflächen die Variationskurven verschieden ausfallen. Wenn ich den seltensten Typ T — oder in Ermangelung dieses Typs den nächsten Nachbartyp — als 1 annehme, so ergibt sich folgendes Resultat (Tabelle I).

Figur 4 zeigt die originelle, d.h. natürliche, primäre Sammelstelle unserer *Balanus improvisus*-Exemplare von 0 bis 40 cm Tiefe entlang der Küstenpartie, wo wir die Sammlungen angestellt hatten.

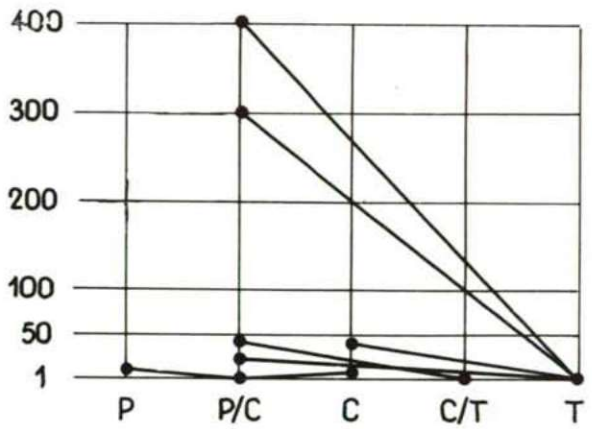
TABELLE I

Ansiedlungs-Oberflächen	Pyramide	Pyr/Zyl	Zylinder	Zyl/Tri	Trichter	Kulminiert
Pachygrapsus	3	1				—— P
Zea mays	12	46	14	1		—— P/C
Phragmites	4	403	305	6	1	—— P/C
Mytilus	140	300	60	4	1	—— P/C
Kleine Mollusken	10	25	5	2	1	—— P/C
Aloidis		13	41	10	1	—— C
Algen		1	1.3			—— C

Also
k u l m i n i e r e n d
sind die Angaben
wenn 1 P/C : P : 3 : 1
„ C/T : P/C : 46 : 1
„ P/C : C : 1.3 : 1

wenn 1 : T : P/C : 403 : 1
„ P/C : 300 : 1
„ P/C : 25 : 1
„ C : 41 : 1

Im
GRAPHIKON 1



Wir haben gesehen, dass an Tabelle I. paarweise je mehrere Ansiedlungsoberflächen-Angaben anderen ähnlich erscheinen, wie es z.B. an den Tabellen II. und III. nach Verwandtschaften zu ersehen ist:

TABELLE II

Ansiedlungs-Oberfläche	P	P/C	C	C/T	T
Zea mays +	12	46	14	1	
Aloidis		13	41	10	1
Pachygrapsus +	3	1			
Algen		1	1.3		
Mytilus +	140	300	60	4	1
Phragmites	4	403	350	6	1
Kleine Mollusken	10	25	5	2	1

Wenn A = dominate, B = subdominate, C = influente, D = subinfluente und E = die seltensten Zahlenangaben bedeuten, so ist Tabelle III. fertig wie folgt:

TABELLE III

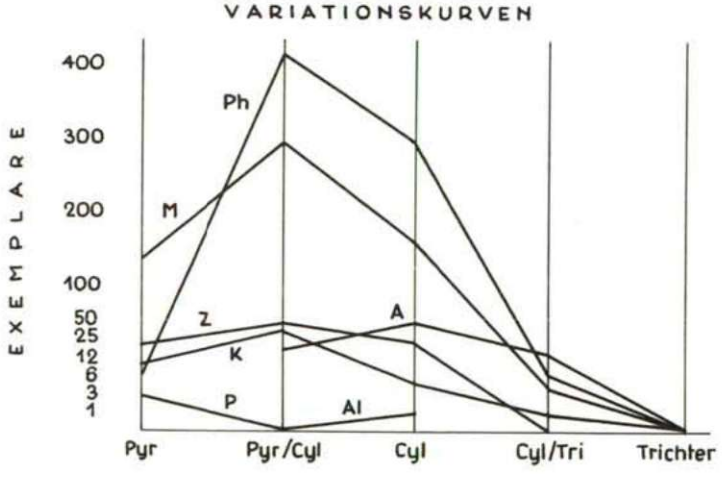
Ansiedlungs-Oberfläche	Dominanzverhältnisse
Zea — Aloidis	BABC
	BABC
Pachygrapsus	AC
Mytilus — Kleine Mollusken	CB
	BACDE
	BACDE
Phragmites	DABCE

Verwandte Ansiedlungseigenschaften sind also *Zea* und *Aloidis*, sowie die kleinen und grossen *(Mytilus)* Mollusken. Krebstiere, Algen und *Phragmites* haben hinsichtlich der Relationen der Balaniden und Ansiedlungsoberflächen ganz besondere Eigenschaften.

(Siehe übrigens Graphikon I.)

P = *Pachygrapsus*, K = Kleine Mollusken, Z = *Zea mays*, A = *Aloidis*, Al = *Algen*, M = *Mytilus* und Ph = *Phragmites communis* — determinierte Balaniden-Variationskurven:

GRAPHIKON 2



Ähnlichkeiten sind noch in den folgenden vergleichenden Angabenzusammenstellungen zu beobachten: Auf *Phragmites* und *Mytilus* ist dominant der Hybriden-Typ P/C, auf *Zea* und kleinen Mollusken ist subdominant der Rein-Typ P, auf *Aloidis* ist dominant der Rein-Typ C, auf *Pachygrapsus* ist dominant der Rein-Typ P.

Die Variationen

Überblickt man nun, in welcher Weise die Veränderung der Absoluten-Anzahlen die Proportionsangaben — ungeachtet der verschiedenen Ansiedlungsoberflächen — verändert, so kommt man zu folgenden Resultaten:

Typen	nach 1000	nach 6000	nach 12.847 Exemplaren
P	41	92	50
P/C	74	161	82
C	7,8	37	26
C/T	1,7	6	6
T	1	1	1

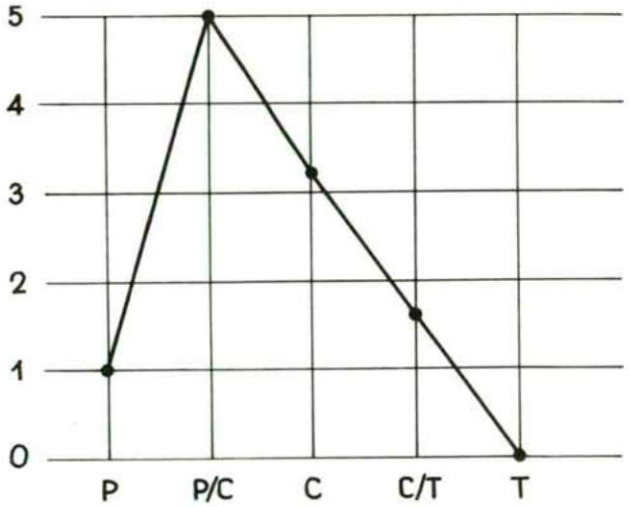
Diese Variationen sind unabhängig von äusseren Faktoren — während in Teilen eine Abhängigkeit doch festzustellen ist.

Der Gesamtunterschied der drei Zahlenangaben (nach 1000, 6000 und 12.847 berechnet) ist folgender:

41 — 92 — 50 —	1(12—50—41)
74 — 161 — 82 —	5(161—92—74)
7.8 — 37 — 26 —	3.2(37—26—7.8)
1.7 — 6 — 6 —	1.7(6—6—1.7)
1 — 1 — 1 —	0

Also graphisch dargestellt:

GRAPHIKON 3



Sehr interessant ist, dass in meinen Studien an baltischen (Kolobrzeger) Exemplaren (1) *Pachygrapsus* für den Typ P ebenfalls fast ausnahmslos charakteristisch war. Dieser Krebs — und auch die anderen Arten der Brachiuren — trägt — bzw. tragen — diesen Typ ausgezeichnet. Der Typ besitzt eine grosse Affinität zu diesen Krebstieren auch in Larvenstadien. Der Umstand, dass die Imagos und Larven z.B. von *Verruca* munter im Schwarzen Meer (P o r u m b) und in der Adria leben (G a m u l i n - K o l o s v á r y), obwohl seine Imagos weder im

Pontikum, noch in der Adria zu finden sind, beweist seine Larvenempfindlichkeit überhaupt!

Wir werden die Variationen der vom mir durchforschten Kolobrzeger-baltischen, der Greifswalder-Ryckschen-baltischen und der hiesigen Materialien vergleichen. Diese Variationen unterschieden sich voneinander quantitativ, aber nicht qualitativ.

Das S u b k l e w'sche Material aus Greifswald-Ryck auf Bollwerk 1959 verteilt sich nach Typen folgendermassen:

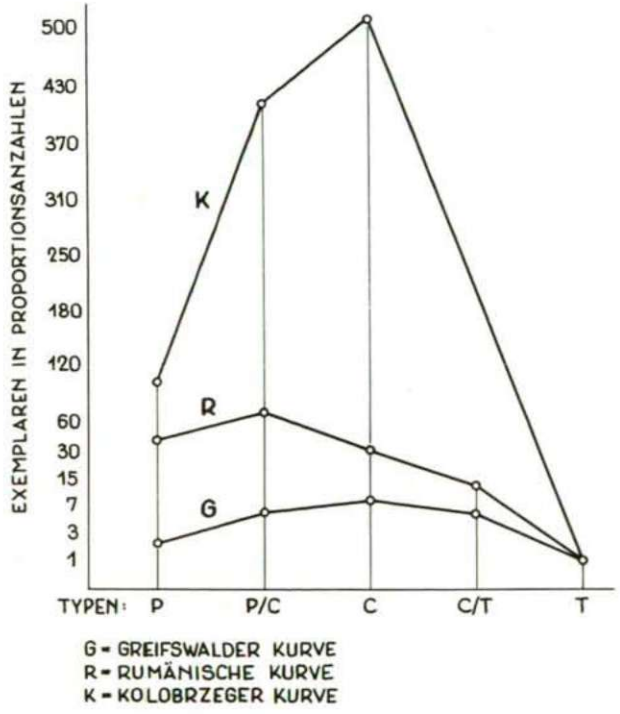
P	41		2	P
P/C	167		6	P/C
C	177	in	7	C
C/T	131	Proportionen	5	C/T
T	24		1	T

Kulminierend war der Typ C—wie bei uns in dem Material auf *Aloidis*. Diese zweifachen Kulminationen zwischen P/C und C bedeuten, dass eine Mobilisierung betreffs des Mittelwertes vorliegt. *Das ist eine Elastizität des Mittelwertes.*

Ich hatte in meiner Arbeit (1) über die Variationsverhältnisse der Kolobrzeger Balaniden festgestellt, dass der *Urtyp der Zylinder ist.* Die Kulminationen zwischen P/C und C weisen darauf hin, dass schon in einer ontogenetischen Grösse von 0,5 mm die Typen P, P/C und C unabhängig voneinander distinguiert erscheinen.

Ohne Berücksichtigung der verschiedenen Ansiedlungsoberflächen ist eine interessante allgemeine Variationskurve zwischen den Kolobrzeger, Greifswalder und Rumänischen Materialien festzustellen wie folgt:

GRAPHIKON 4



Vergleichen wir nun die drei Materialien betreffs der Dominanzverhältnisse, so kommen wir zu den folgenden Resultaten:

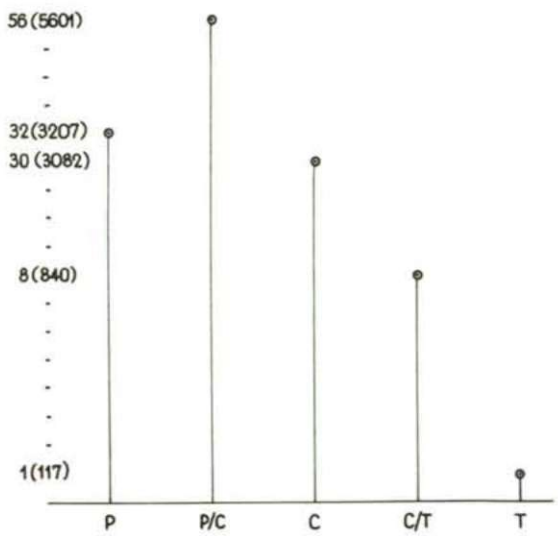
Das Material und die Gesamt-Exemplar-Anzahl	Typ	Eigenschaften
Rumänien 12.847	P	subdominant
	P/C	*DOMINANT*
	C	influent
	C/T	subinfluent
	T	selten
Polen 3400	P	subdominant
	P/C	subdominant
	C	*DOMINANT*
	C/T	selten
	T	selten
Deutschland 550	P	selten
	P/C	subdominant
	C	*DOMINANT*
	C/T	subdominant
	T	selten

Eine allgemeine *Progression* von P zu P/C ist bei allen drei Materialien festzustellen. Diese Progression von P/C zu B behält ihre Stärke bei. Hier ist eine grosse Elastizität zu beobachten. — Eine *Regression* von C zu T ist zweifellos und überall — eigentlich als allgemeine Regelmässigkeit — vorhanden. — Der *konservative* Punkt der Eigenschaften ist C, wo die kleinsten Unterschiede zu beobachten sind (2000—200).

Auf Grund dieser Erörterungen können wir im folgenden die phylogenetische Eigenschaftsreihe aufstellen:

Konservative Eigenschaften	Elastische Eigenschaften	Progressive Eigenschaften	Regressive
Typ C — Urtyp	P/C zu C zu C/T	P zu P/C	C/T zu T

GRAPHIKON 5



Wenn wir annehmen, dass der Urtyp als Grund 1 ist, so muss die elastische Bewegung mit 5 Indexen bezeichnet werden. Die Progression verhält sich zur Regression wie 20:50. Es bedeutet die Tatsache, dass der Abfall unserer Kurven immer grösser ist als die Bewegung der anderen Punkte der Kurve.

An dem folgenden Graphikon sehen wir die Absolutzahlen der 12.847 Exemplare als Variationsendresultat der von den rumänischen Küstenpartien stammenden *Balanus improvisus* Seepocken.

Deformationen

Was nun noch die Deformationen anbelangt, wiese ich darauf hin, dass Subklew (1961) bei der Erörterung des Einflusses von Leuchtfarbstoffen auf Balanidengehäuse eine „Kümmerform" erwähnt. Im allgemeinen ist unsere Art eine Ansiedlungsubiquistin und Subklew hat auch Recht, dass die Art „keine Ansprüche an das Substrat" stellt. Ich muss aber bemerken, dass dieser Ubiquismus oder Kosmopolitismus nicht ausschliesst, dass sich an verschiedenen Oberflächen die Konstitutionstypen (weder Anpassungsformen im Sinne O. Abel's noch anderer Autoren) verschiedenerweise verbreiten lassen — nach der Auswahl des Substrats schon von Seiten der Larven womöglich in natürlichem Zustande — d.h. unberührt von anderen zwingenden Umständen. — Die Typen müssen endogenerweise determiniert werden wie die Konstitutionstypen im Tierreich und in der Menschheit im allgemeinen (wo die richtigen Studien von Seiten der Ärzte durchgeführt worden sind). — Über Mammalien hat bei uns in Ungarn Professor Dr. Geyza von Anghi-Csaba sehr schöne und ergebnisreiche Studien durchgeführt, und ich halte Professor Anghi-Csaba für den berühmtesten und exzellenten Forscher der tierischen Konstitutionen betreffs der Wirbeltiere. — Die Wirbellosen, d.h. richtiger die Protostomier, können auch keine Ausnahme von den Gesetzmässigkeiten der Konstitutionen sein und es ist sehr wichtig, überhaupt zu distinguieren zwischen mit systematischem Wert versehenen, morphologischen Verschiedenheiten und in systematischem Sinne bedeutungslosen Konstitutionstypen.

Umgebungsfaktorialien bringen nur Deformationen hervor, die in der Reihe der Balanidengehäuse-Verschiedenheiten sehr mannigfach sind. Diese Deformationen können auch Pseudo-Zylinder und Pseudo-Trichter sein, — allein die Relation von Basis und Orifizium berechtigt, die Gestalt des Balanidengehäuses deformativ oder konstitutionell zu qualifizieren.

Zusammenfassung

Ich habe im Oktober des Jahres 1966 mit meiner Frau an den rumänischen Küstengebieten des Schwarzen Meeres 12.847 Exemplare von *Balanus improvisus* Darwin gesammelt und nach Typenvariationsstudien in statistischer Hinsicht untersucht.

Die Gehäusevariationen haben zwei Ursachen: Seitens der äusseren

tutionstypen. Letztere zeigen eine Verteilung nach Ansiedlungsoberflächenverschiedenheiten, wie z.B. nach Seekrebsen, Molluskenschalen, Algen und ins Meerwasser gefallenen *Zea*-Stengeln, sowie in Brackwasser nach *Phragmites communis* usw.

Der Urtyp ist der Zylinder. Der Variations-Mittelwert schwankt zwischen P/C und C, und von den Extremen ist die Pyramide häufiger als der Trichter.

Der Rein-Typ P ist dominant bei *Pachygrapsus* und anderen Seekrebsen. Der Rein-Typ C ist dominant bei *Aloidis*. Der Hybriden-Typ P/C ist dominant bei *Phragmites communis* und *Mytilus e. galloprovincialis* und der Rein-Typ P ist subdominant bei *Zea mays*-Stengeln und im Falle von kleinen Molluskenschalen.

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Bahls, H. (1903): Über Struktur und Wachstum der Schale von *Balanus improvisus*. Inaug, Diss. Greifswald.

Anschrift des Verfassers:

Prof. Dr. G. Kolosváry
Syst.-Zoologisches Institut der A. J. Universität Szeged, Ungarn

Acta Biologica Szeged *13*, (3—4), pp. 153—157 (1967)

ÜBER DEN BEWUCHS DES UNGARISCHEN MEERES-SCHIFFES „TATA"

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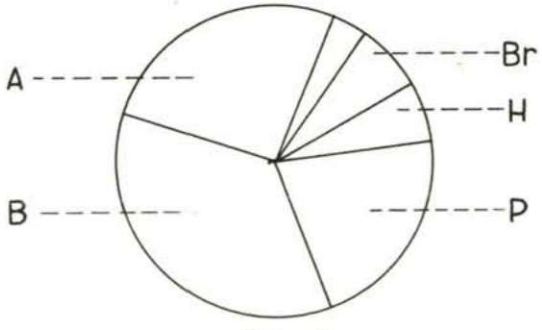
Syst. Zool. Inst. Attila József Univ. Szeged — Ungarn

(Eingegangen am 9. Október 1967.)

Es wurden mir vom Herrn Kapitän L. Körmendi aus dem Bewuchse des ungarischen Meeres-Schiffes „TATA" im Jahre 1966 freundlichst Proben überlassen. Ich sage Herrn Kapitän L. Körmendi meinen herzlichsten Dank für diese Hilfe auch im Namen der ungarischen Hydrobiologie.

Das Material kam ausgetrocknet zu menien Händen und war voll mit ungeheueren Mengen von kleinen Polychäten-Kalkröhrchen. Ausser den Algen und tierischen Objekten war überaus viel Minium und Teer. d.h. Bitumenschicht, Bitumenanstrichen vorhanden. In dieser Masse waren viele Balanidengehäuser, Polychätenröhrchen — u.zw. in verschiedenen ontogenetischen Stadien — eingebettet.

Die ganze Bewuchsprobe war jung und stammte von *Roten Meere,* wo nach den Benachrichtigungen des Herrn Kapitän L. Körmendi das See-Schiff „TATA" mehrere Wochen hindurch navigiert hatte.

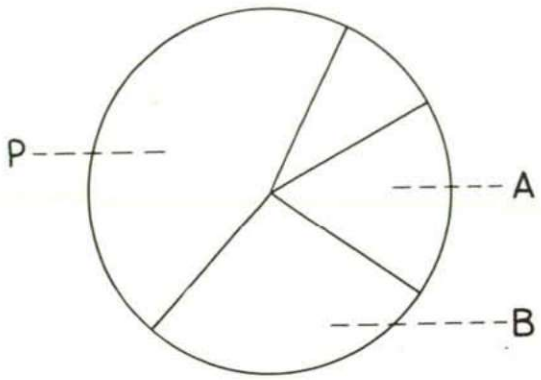


Figur 1

Die Literatur der Bewüchse der ungarischen Donau-Meer-Schiffe findet der Leser in *„Acta Biologica Szegediensis"* Tom. XI. Fasc. 3/4. 1965. p. 271—277. — Daraus wird ersichtlich, dass das See-Schiff „TATA" das siebente ist, welches ich untersuchte und welches in Vergleich zu den anderen sechs Schiffen neue Bewuchselemente aufweist.

Ich veröffentliche die Untersuchungsergebnisse meiner Studien und gebe einen Vergleich zwischen der Bewuchsbiozönose des See-Schiffes „TATA" und die für das *Mediterraneum* charakteristische *Kühl*'sche Figur wie folgt:

Textfigur 1. nach K ü h l (1962 b) Br: Bryozoen; H: Hydrozoen; P: Polychäten; A: Algen und B: Balaniden.



Figur 2

Textfigur 2. nach meinem Untersuchungen: A: Algen; B: Balaniden; P: Polychäten.

Polychäten

Es wurden gefunden: ungeheuere Mengen von sedentarien Serpulimorphen, d.h. festsitzenden Serpuliden mit kleinen Röhrchen aus weissem Kalk. Seltener ist *Serpula vermicularis*. Es wurden noch viele *Spirorbinae* mit unsymmetrischen Körpern angetroffen, schwer trennende Arten — auch auf allen Unterlagen, sogar Algen vorkommend, nieder heranwachsend samt *Protula tubularia* (M o n t.).

Die Mengen dieser sedentarien Bewuchselemente determinieren die Eigenschaft des Gesamtbewuchses als eine „Polychätosedentarium"-Gesellschaft, wo innerhalb und zwischengelagert die Balaniden nur eine subdominante Biomassa darstellen.

Nach der Literatur (U t i n o m i et H a r d a, 1958) sind z.B. aus J a p a n im Schiffsbewuchs 7 Genera und 7 Arten von Polychäten bekanntgeworden. Mehrere Autoren (K ü h l, 1954) erwähnen nur „Serpuliden" im allgemeinen, ohne eine nähere Diagnose zu geben. Von Serpuliden waren die wichtigsten Bewuchsglieder (K ü h l, 1962 b): *Hydroides* mit Busch- oder Hydroidengestalt; *Merceriella enigmatica* F a w e l mit charakteristischen Kalkröhrchen und *Pomatoceros* mit kurzem, mehr oder minder Kiffelartigen und bekanteten Kalkröhrchen.

Im allgemeinen assoziieren die Balanidengemeinschaften auch im Atlantik (L e f e v e r e, 1952), mit *Merceriella enigmatica* F a w e l oft und ordinär.

Balaniden

Balanus amphitrite Darwin

Junge und semiadulte Exemplare innerhalb des Balaniden-Bewuchses dominierend vorkommend. Die Individuen haben einen Basisdiameter von 1 bis 12 mm. Artzugehörigkeit durch die Operkularlamellen determiniert auch unzweifelhaft.

Besiedlungseigenschaft der Art *Balanus amphitrite* Darwin: subtropisch-tropisch!

Balanus improvisus Darwin

Junge Exemplare, selten vorkommend. Wachstumsgrösse von 2 bis 6 mm. Artzugehörigkeit unzweifelhaft. Besiedlungseigenschaft: palaearktisch-subtropisch. Euryhaline und eurytherme Art.

Balanus glandula Darwin

In 3 jungen Exemplaren gefunden. — Selten. Basisgrösse 1.5 bis 3×3 mm. — Mauerkrone dünn und zerbrechlich. Parietaltuben nur in Basisgegenden in Spuren zu beobachten. Mauerkronen-Höhe 4 mm; Gehäuse äusserlich mehr oder minden glatt oder quergerunzelt. — Radii eng; Innenseite der Lamellen glatt. Eine breite Variabilität der Tuben- und im allgemeinen der äusseren Morphologie — ist zu konstatieren (Cornwall, 1951). — Rostrum besitzt innerlich in Mediastinum einen apikalen Kiel, wie es bei der Art *Catophragmus imbricatus* Sowerby auch der Fall ist (Henry, 1958). — Carina mit Alae; Carinolaterale fast so breit wie Laterale; nur die Radii sind grösser als die der Lateralia. Parietalia manschmal auch mit Längsrippen.

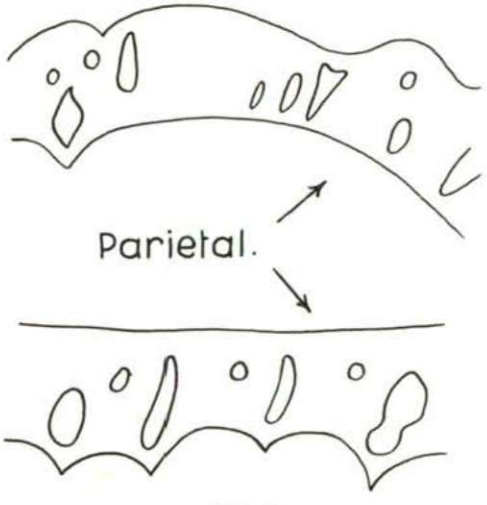


Fig. 3

Was die Operkularplatten anbelangt ist das Scutum mehr breit als hoch; äusserlich nur quergestreift. — Tergum trapezartig mit drei scharfen Cristae für mm. depressores. Spur ganz abgerundet, das tergale Margin mit Längsstreifen (s. Pilsbry, 1916).

Unser Fund stimmt im allgemeinen mit den Beschreibungen von Darwin und Pilsbry überein. Was die Cornwall'schen „Interlaminate figures" angelangt, findet der Leser in Fig. 1. die Schemen (originale Grösse 1 mm) der Parietalia und in Fig. 4. die der Alae von Cornwall (1958) dargestellt. — Leider konnte ich wegen der jugendlichen, d.h. sehr zerbrechlichen Konsistenz unserer Exemplare keine Schliffe machen um sie in dieser Hinsicht nachprüfen zu können.

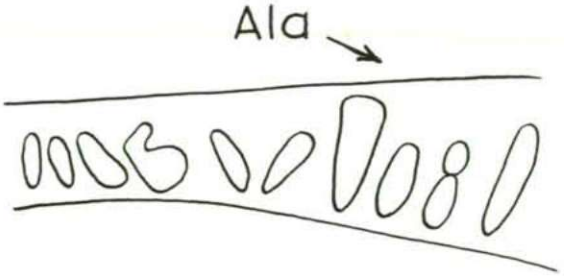


Fig. 4

Die Art *Balanus glandula* Darwin ist eine sehr variable Balanide (Cornwall, 1955 b). — Ihre Heimat sind die Aleuten-Inseln bis zu Kalifonien „chiefly in the intertidal zone. Abundant on rocks; occasionally in brackish water and on ships bottom". Die Grösse der Adulten ist 10—18 mm (6.3). — Von den Anheftungsobjekten sind bekannt: Lamellibranchiaten, *Balanus nubilus; Pollicipes polymerus* (Pilsbry, 1916); *Lottia gigantea. Capulus hungaricus* (Kolosváry, 1943); *Chthamalus, Thais, Pisaster, Littorina, Acmaea, Hemigraphus, Diodora, Tetraclita* (Kolosváry, 1943; Pilsbry, 1916) meldet sie „on jetty" d.h. als Hafenbewuchsglied! Ausser den Aleuten und Unterkalifornien sind noch Anmerkungen über ihr Vorkommen von Massachusetts (?); San Juan Archipélago und Pouget Sound (Kolosváry, 1943) bekannt.

Zusammenfassung

Protula tubularia und *Balanus glandula* wurden als neue Schiffsbewuchsmitglieder der ungarischen Meeres-Schiffe festgestellt. Als Schiffsbewuchsmitglied ist *Balanus glandula* nur sekundärerweise zu beurteilen, weil — aller Wahrscheinlichkeit nach: das Schiff „TATA" sich in einem Hafen durch ein Nachbarschiff infizierte. Das Schiff „TATA" navigierte weder in Kalifornien, noch in den Aleuten — soweit ist *Balanus glandula* als ein Hafenbewuchsmitglied festzustellen. Sieke Tafeln I., II. und III.

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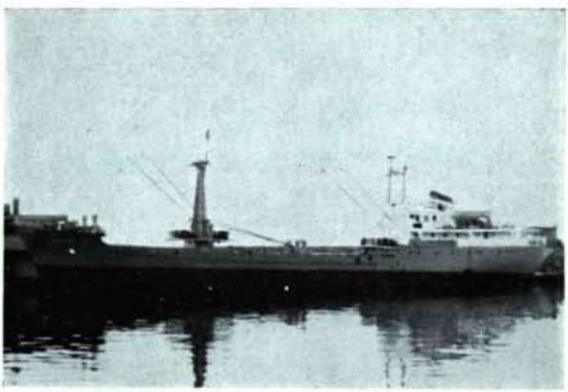
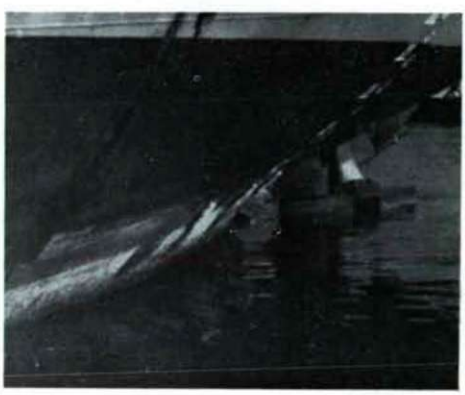
TAFEL I





Schiff „Tata" und Seitenflächen mit den Schiffbewüchse.

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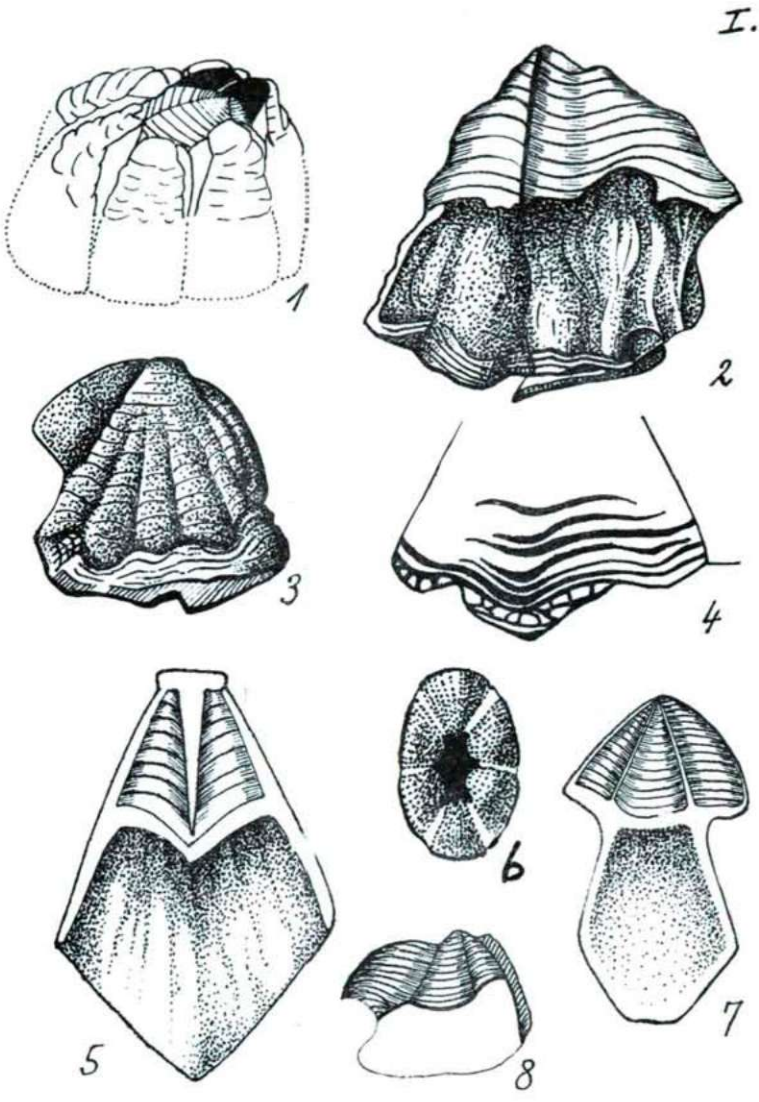
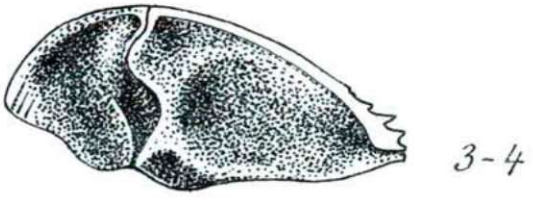


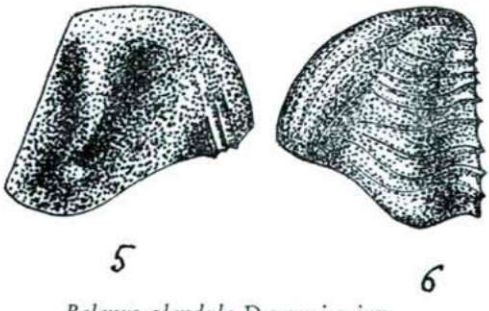
Balanus glandula D a r w i n, *juv.*

1 : Mauerkrone (punktiert in Bitumen eingebettet).
2 : Laterallemelle (Innenseite).
3 : Laterallamelle (äussere Seite).
4 : Kalzifikationsstreifen und Tubeneneden in Laterallamelle.
5 : Rotsrum (Innenseite).
6 : Mauerkrone von oben gesehen (schematisch).
7 : Carinolaterale (Innenseite).
8 : Laterale (Innenseite).

Orig. gez. Autor.

TAFEL III





Balanus glandula D a r w i n *juv.*

1—2 : Scutum und Tergum (äussere Seite).
3—4 : Scutum und Tergum (Innere Seite).
5 : Tergum, separiert vom innen gesehen.
6 : Tergum, separiert von der äusseren Seite gesehen.

Orig. gez. Autor.

Acta Biologica Szeged *13*, (3—4), pp. 159—161 (1967)

BEITRÄGE ZUR KENNTNIS DER LADIN- UND LIASSKORALLEN VON JUGOSLAVIEN

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(Eigegangen im 13. Október 1967.)

Im Jahre 1967 bekam ich vom Herrn Kollegen Dr. A. Ramovs aus Ljubljana — mehrere Objekte von fossilen Madreporarien aus Jugoslawien, welche ich determinierte und bezüglich derer ich die folgenden Resultate erhielt:

Mittel-Trias

Thecosmilia badiotica Volz — von Leskovica in dunkelgrauem Kalk Polypenfragmente mit Durchmessern von 5—10 mm eingebetett und stark verkalkt. Die Polypengrösse und die stacheligen Sclerosepten beweisen, dass hier betreffs der Artzugehörigkeit kein Zweifel besteht. Die Art gehört der charakteristischen Marin-Fauna des Ladins an.

Thecosmilia subdichotoma (Münster) — Storzic am Weg Preval — Storzic, etwa 50 m unterhalb des Gipfels. Koloniefragmente in hellgrauen Kalk eingebettet und ziemlich verkalkt. Polypendurchmesser 5 mm (selten grösser). Die Sclerosepten I. Ordnung stereoplasmatisch dick entwickelt (Abb. 2). Andere Objekte — ebenfalls von Storzic 2080 m in dunklen-grauen und bräunlichen Kalk eingebettet Kolosváry (1963). — Die 6 Protosepten sind gut wahrzunehmen, da sie sich am stärksten ausbildeten. Die Polypenröhren stehen nicht ganz charakteristisch dicht nebeneinander, weil sie relativ lockere d.h. degenerative Stellung einnehmen. Die Art ist sehr gemein im Mitteltrias. Endothek wegen der starken Verkalkung kaum gut observieren. Septen z.T. unregelmässig ausgebildet (Abb. 2).

Thecosmilia cf. sublaevis Münster — Storzic, 2080 m. Polypenfragmente in dunkelgrau-bräunlichen Kalk eingebettet mit einem Polypendurchmesser von 6—7 mm. Die Septen I. Ordnung (in einer Anzahl von 6—8) in der Mitte des Kelches regelmässig konfluent. Sclerosepten-cyclus 3—4 — d.h. die Sclerosepten der II. und III. Ordnungen sind unregelmässig ausgebildet. Endothek schlecht erhalten und kaum recht zu observieren. Septenanzahl 50—54, ebenfalls nicht genau zu zählen (Abb. 4) und noch Literatur Kolosváry (1966 a).

? *Montlivaltia* sp. indet. — Drmalka-Gebirge, neu Trzic, oberer Teil der longobardischen Stufe des Ladins. Ein Polypendurchmesser von 12×14 mm Grösse mit herzförmigen Konturen (Abb. 1). — In dunkelgrauen Kalk eingebettet. Aehnlich dem Fund aus der CSSR Kolosváry (1957). — Die Sclerosepten sind untereinander conophyllaähnlich konfluent. Septenanzahl cca 68. — Kolumelle fehlt vollkommen. Endothek dicht ausgebildet. Durch Konfluenz der grossen Septen kann man des Kelchraumes 4 Sektoren innerhalb unterscheiden, d.h. es sind ein dorsaler, ein ventraler und 2 laterale Sektoren zu beobachten. So bildete sich ein palaeozoischer Charakter heraus. Ich fand diese fragliche *Montlivaltia* schon zum zweiten Male, aber nur je in je 1 Exemplare. Die Koralle trägt einen prolongierten Konservativismus und ich habe sie bisher weder in Alpenländern, noch in Pannonien und in Nord-Ungarn gefunden. — Die Vermischung der Charaktere der echten *Montlivaltia* und echten *Conophyllia* (mit Kolumellen) scheint mir nicht auszuschliessen, dass wir hier eventuell eine neue Art kennen zu lernen die Möglichkeit haben, die provisorisch als *Pseudomontlivaltia longobardica* zu bezeichnen wäre.

Margarosmilia confluens (Münster) — Draga, in dunkelgrauen Kalk eingebettetes Koloniefragment mit 8—9 Polypen. Oberfläche mergelig. Polypendurchmesser zwischen 5 und 8 mm schwankend. Kolonienhöhe 15 mm. Septenanzahl cca 60, nicht ganz genau zu zählen. Epithek dünn; die Sclerosepten in der Mitte spindelförmig verdickt Papp (1900).

Untere Jura (Liass)

Epismiliopsis sp. indet. — Jelovica; ein einziger Polyp in hellgraugelben Kalk eingebettet. Durchmesser an der Seite I.: 9×9 mm und an der Seite II.: 8.5×10 mm. — Solo Koralle. Septenanzahl 42. — Die Serosepten der und III. Ordnungen ungleich entwickelt (Abb. 3).

Eine zusammenfassende tabellarische Stratigrafie ist

Alter	Art	Von mir bisher bekannte Fundstellen
Praecassian und Cassian vom Marmolata bis Raibli	*Th. badiotica*	Alpen, CSSR, Pannonien, Nord-Ungarn, Jugoslavien
„	*Th. subdichtoma*	„
„	*Th. sublaevis*	Alpen, CSSR, Jugoslavien
Longobardisches	? *Montlivaltia* sp. indet.	CSSR und Jugoslavien
Praecassian und Cassian vom Marmolata bis Raibli	*M. confluens*	Alpen, CSSR, Pannoninen (dominant), Nord-Ungarn, Jugoslavien
Liass	*Epismiliopsis* sp. indet.	Jugoslavien

— Wand endothekal-epithekal von peripherischen Dissepimenten ausgebildet. Endothek tief. Septen kompakt und die Septen II. Ordnung dünn und der III. Ordnung unregelmässig reduziert. Eine Kolumelle fehlt vollkommen. Nur in der Liass lebender Genus Alloiteau (1957). — Synonymen: *„Montlivaltia"* und *„Epismilia"*. — Die 6 Protosepten sind recht schön wahrzunehmen: den dorsalen und ventralen Sektor ausbildend und je 2 lateralen Sektoren gut wahrnehmbar machend. Aeussere Rippung vorhanden.

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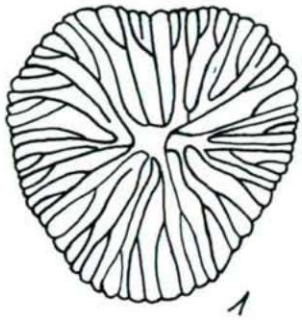

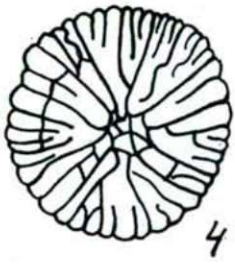

Abb. 1. : ? *Montlivaltia* sp. indet. Kelch in natürlichen auserodiertem Zustand 12 × 14 mm.
Abb. 2. : *Thecosmilia subdichotoma* Polypendurchmesser geschliffen 5 × 5 mm.
Abb. 3. :*Epismiliopsis sp.* indet. Kelch geschliffen 9 × 9 mm.
Abb. 4. : *Thecosmilia sublaevis* Kelch (auserodiert) 6 × 7 mm.
Originalzeichnungen des Verfassers.

Acta Biologica Szeged *13*, (3—4), pp. 163—174 (1967)

ANALYSIS OF THE ANTHROPOLOGICAL MATERIAL OF THE 10—11th CENTURY CEMETERY IN ALDEBRŐ-MOCSÁROS

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(Received October 31, 1967)

The circumstances of the excavation

The museologist J. Szabó from Eger made rescue excavations in 1962 in the area of Aldebrő-Mocsáros and opened up 31 graves. They were all oriented in West-East direction, their age can be ranged into the second part of the loth century. The western part of the cemetery is ruined, but the peripheries of the other parts could be reached in all directions (Szabó, 1963). As the archeological material has been so far not been reported it seemed advisable to give a short archeological description of the cemetery.

At least 50 per cent of the graves have no finds (mostly male and children graves). Generally the other graves contained: ear rings, bracelets, quivers, iron knives, iron clasps, rings, stirrups, and eared buttons. Among the archeological fnids of this cemetery the discs ornamented with griffins from the 20th grave are remarkable (Szabó, 1963). The archeological finds of the graves suitable for anthropological analysis are according to the notes of J. Szabó as follows.

Author wishes to express her thanks to J. Szabó for placing the list of graves of the 10—11th century cemetery in Aldebrő-Mocsáros at her disposal.

Grave 9: Quiver packed with arrows, iron knife, iron clamp, horses harness, a pair of stirrups. Length of the skeleton measured in the grave: 162 cm. Depth 80 cm; male.
Grave 10: Iron knife. Skeletal length: 165 cm. Depth 54 cm; male.
Grave 14: Had no find. Skeletal length: 159,9 cm. Depth 66 cm; male.
Grave 15: Clay pot, silver hair rings, ring. Skeletal length: 161 cm. Depth 57 cm; female.
Grave 16: Ring. Skeletal length: 160 cm. Depth 65 cm; male.
Grave 19: Arrow tips, iron knife, iron clamps, eared button. Skleletal length: 154,2 cm. Depth 42 cm; male.
Grave 24: Had no find. Skeletal length: 164 cm. Depth 78—85 cm; female.
Grave 25: Two eared buttons. Skeletal length : — . Depth 71 cm; female.
Grave 29: Had no find. Skeletal length: 146,8 cm. Depth 82 cm; female.

Anthropological analysis

The Museum of Eger sent the material of 30 graves to the Anthropological Institute of the József Attila University to be examined. The finds of 16 are well preserved (therefore suitable for metrical analysis). 10 adults (6 males and 4 females) the others are subadults

and children. From 8 graves skulls and skeletons, from 1 grave only the skull and from 1 only the skeleton were unearthed. There were 14 fragmentary skeletons (thus unsuitable for metric analysis) the outlined analyses of which are summarized at the end of the paper in Table 6.

According to the age categories, the majority of the males can be ranged into the mature group, whereas most of the females can rather be considered as members of the adult one.

On the basis of Martin's method (Martin, 1928) the general analysis of the series according to Table 1. and taking also the morphological characteristics into consideration is, as follows. (Owing to the insignificant quantity of well — preserved — thus measurable — anthropological material, parameters were not calculated.)

The *crania* of the males mostly show a dolichocranic tendency, whereas the cranial indices of the females are higher (brachycrany and mesocrany). The *cranium* of the males is usually hypsicranic and metriocranic, and that of the females rather orthocranic and tapeinocranic. The cranial capacity of the males is characterised by oligencephaly, whilst that of the females by euen- and aristencephaly. The frontals are in both sexes eurymetopic. The *glabella* is generally pronounced (degrees 3 and 4) in the males and slight in the females (degrees 0 and 1). The contour of the *cranium* of the males is very variable in the vertical norm: pentagonoid, ellipsoid, ovoid; that of the females mostly ovoid. In the case of both sexes is gable shaped the occipital norm. The *protuberantia occipitalis externa* is in males generally of degree 2, while in females it is rather of degree 10 and 1. The *processus mastoideus* is pronounced in males and slight in females. Leptoprosopy is characteristic for the faces of the males and mesoprosopy for those of the females. The upper facial index in usually in both sexes mesene. The *fossa canina* is mostly deep or of medium deep. The orbital index is mesoconch and chamaeconch in males and meso- and hypsiconch in females. The nose protrudes slightly or to a medium extent, according to their indices meso- and chamaerrhiny dominates. The *spina nasalis anterior* is in the males of degree 2 and 3 and in the females it is generally broken. On the basis of the facial profile angle both sexes are orthognath. Their alveolar prognatism is usually of degree 2. The stature of the males is short and short medium or tall-medium and that of the females rather short medium (Table 2).

Table 3 shows the metrical characters of the adults and Table 4 those of the subadults and children.

The anatomical variations which can be seen on the skulls are as follows. In males the *os epiptericum* was found twice (grave 19, on the right; grave 14, on the left) and in females once (grave 24, on the right). Suture bones in the lambdoid region occurred only in a male in one case (grave 10). On the skull of grave 16 a manifestation of *atlas* can be detected.

The skull of grave number 20 is trephined and that of grave number 29 is symbolically trephined. (The detailed analysis of these two *crania* will be reported in a later paper together with the description of trephined *crania* of another cemetery.)

From this small series far reaching conclusions cannot be drawn; the anthropological description of the series reveals that there is no marked difference between males and females (only the cranial index shows some difference). The performed taxonomical analysis also conforms this.

P. Lipták kindly helped ne with the taxonomic analysis; it was performed by his method. Author would like to express her thanks to him.

The *crania* belonging to the brachycranic group can be well distinguished (graves 19, 25, 29). All the three represent the Pamirian race particularly grave 25 (Plate I). Brachycrany, orthocrany and tapeinocrany characterise its *cranium*, the *glabella* is shallow. The vertical profiling is moderate. The frontal is steep, according to its index it is eurymetopic. The nose protrudes moderately, is slightly bent, on the base of its index chamaerrhine. In the temporal norm a slight lambdoid flattening can be noted. The *crania* of graves 19 (Plate II) and 23 also show Pamirian characteristics but these main features are mixed with some other characteristics. Three graves also belong to the Mediterranean group: graves 14 (Plate III), 16 (Plate IV) and 24 (Plate V). The skeletal material of grave 14 exhibits Mediterranean features — the *cranium* is dolichocranic, hypsicranic, akrocranic, the stature short medium — but they are also mixed with Cromagnoid-A and some other undetermined characteristics. The orbits are rectangular, according to the index mesoconch, the nose is protruding, erect, low and broad (euryprosopic, euryene), the face slightly angular. The other two *crania* show definite Iranian characteristics associated with some secondary component. Their common trait is a low cranial vault, a sloping forehead, and a strongly protruding nose which is also sloping. After the first mentioned two groups the Nordoid one should be ranged containing 1 male and 1 female (graves 9 and 15). The *cranium* of grave 15 is characterised by dolichocrany, hypsicrany and akrocrany, the forehead is slightly sloping, the face leptoprosope, mesene, the orbits are moderately angular, on the base of its index is mesoconch. The stature is tall medium. Among the males the archaic form of the Nordics (protonordics) characterised by a marked relief can also be found. This *cranium* is hyperdolichocranic, the forehead eurymetopic, the orbits angular and the stature tall medium. The cromagnoid group is the last having only 1 male representative; grave 10 (Plate VI). Within this large group this *cranium* clearly shows the features of the Cromagnoid-A race. The *cranium* is mesocranic, the forehead eurymetopic, slightly sloping, the face hyper-euryprosopic, euryene, the orbits are rectangular, the mandible is high, the region of the gonion protrudes markely, the stature is tall. (The detailed diagnosis of the main taxonomical groups are described in a previously published work of P. Lipták [1962]).

Taking the metric, morphological and taxonomical analyses into account it is striking that the subjects belonging to the same large group show a certain morpho-taxonomical similarity. Such a resemblance can, for example, be found between the Protonordic type of grave 9 and the Nordic one of grave 15, between the Iranian types of graves 16 and 24

as well as between the Pamirian types of graves 19 and 25. The resemblance between these individuals is probably due to a family connection thus it may be concluded that we are obviously dealing with a larger family burial place.

Comparison

The skeletal remains unearthed in the area of Hungary of our days are particulary important because they also shed light on the systematical position of the Europoid and Mongoloid races which lived in Eastern-Europe. The analysis of the series is equally important in small and large series because in this way we can get better acquainted with the anthropological aspect of the analysed population, furthermore the questions of morpho-taxonomical relationship and genetical correlations can be approched. The anthropological component of the conquering Hungarians contains a large percentage of Turanian, Uralian, Pamirian and other Europoid types (L i p t á k, 1955). Although the Turanian type belongs ethnologically to the Turkish groups in the Ural region, the Hungarians actually mixed at several periods with Turkish ethnic groups, thus bringing into the Carpathian bassin a considerable Turanian element. As generally in the case of the Ugrian populations, the Uralian race represents also an appreciable anthropological component of the Hungarian people. As a result of P. L i p t á k 's work the Pamirian type can also be demonstrated among the conquering Hungarians, it was linked to the Turkish component of the Hungarians in the 10th century. The ruling class is usually characterised by the Turanian, Uralian and sometimes by the Pamirian types, the middle class by the Europoid component: the Mediterranian, Nordic and Brachycranic types (L i p t á k, 1965).

The anthropological elaboration of the 10—11 th century cemeteries was mainly performed by L i p t á k (1953, 1958), L i p t á k - F a r k a s, (1967), N e m e s k é r i (1946—48), · A c s á d i - N e m e s k é r i (1957, 1958, 1959), B a r t u c z - F a r k a s (1956). The 10—11th century cemetery Aldebrő—Mocsáros — taking the small amount of well preserved material into account — resembles, owing to the cranial of well preserved material into account — resembles owing to the cranial indices and taxonomical distribution, especially the material found in Veszprém—Sashegy and Székesfehérvár—Kurucdomb (Table 5). Reviewing the taxonomical analysis of the cemeteries presented in Table 5 it is striking that in the cemetery of Aldebrő the Europo-Mongoloid component is completely absent. Thus the domination of the Europoids and in them the presence of the Pamirian type in the 10—11th century cemetery of Aldebrő—Mocsáros provides a certain help for the anthropological analysis of the people belonging to the middle class of the conquering Hungarians, although the cemetery of Aldebrő cannot be considered to be exclusively a cemetery of the occupation.

TABLE 1. Aldebrő-Mocsáros: Distribution of the principal metrical characters

	Characters			Males	Females	Total
8:1 Cranial index	Hyperdolichocranic		65,0—69,9	1	—	1
	Dolichocranic		70,0—74,9	2	—	2
	Mesocranic		75,0—79,9	1	2	3
	Brachycranic		80,0—84,9	—	2	2
	Hyperbrachycranic		85,0—89,9	1	—	1
			Total:	5	4	9
17:1 Length-height index	Chamaecranic		x—69,9	—	—	—
	Orthocranic		70,0—74,9	1	3	4
	Hypsicranic		75,0—x	3	1	4
			Total:	4	4	8
17:8 Breadth-height index	Tapeinocranic		x—91,9	1	3	4
	Metriocranic		92,0—97,9	2	—	2
	Acrocranic		98,0—x	1	1	2
			Total:	4	4	8
9:8 Fronto-parietal index	Stenometopic		x—65,9	1	1	2
	Metriometopic		66,0—68,9	—	—	—
	Eurymetopic		69,0—x	4	3	7
			Total:	5	4	9
47:45 Facial index	Hypereuryprosopic		x—79,9	1	—	1
	Euryprosopic		80,0—84,9	1	—	1
	Mesoprosopic		85,0—89,0	—	2	2
	Leptoprosopic		90,0—94,9	2	1	3
			Total:	4	3	7
48:45 Upper facial index	Euryene		45,0—49,9	2	—	2
	Mesene		50,0—54,9	3	3	6
	Leptene		55,0—59,9	—	1	1
			Total:	5	4	9
52:51 Orbital index	Chamaeconch		x—75,9	2	—	2
	Mesoconch		76,0—84,9	3	2	5
	Hypsiconch		85,0—x	—	2	2
			Total:	5	4	9
54:55 Nasal index	Leptorrhine		x—46,9	—	1	1
	Mesorrhine		47,0—50,9	2	2	4
	Chamaerrhine		51,0—57,9	2	1	3
			Total:	4	4	8
		Males	Females			
38. Cranial capacity	Oligencephalic	x—1300	x—1150	4	—	4
	Euencephalic	1301—1450	1150—1300	—	2	2
	Aristencephalic	1451—x	1300—x	—	2	2
			Total:	4	4	8
72. Total facial angle	Prognathous		70°—79,9°	—	—	—
	Mesognathous		80°—84,9°	1	1	2
	Ortognathous		85°—92,9°	3	3	6
			Total:	4	4	8
		Males	Females			
Calculated stature	Short	150—159,9	140—148,9	2	—	2
	Short medium	160—163,9	149—152,9	2	2	4
	Medium	164—166,9	153—155,9	2	—	2
	Tall medium	167—169,9	156—158,9	2	—	2
	Tall	170—179,9	159—167,9	2	1	3
			Total:	10	3	13

TABLE 2. Aldebrő-Mocsáros: Measurements of long bones

Grave No	Inventory No	Femur		Tibia		Humerus		Radius		Calculated stature
		right	left	right	left	right	left	right	left	
		MALES								
9	DI. 7.	453	449	387	388	332	330	255	259	167
10.	DI. 8.	464	458	388	387	346	—	252	256	170
11.	DI. 9.	469	466	399	397	—	—	—	—	171
14.	DI.12.	417	420	362	361	296	280	—	232	160
16.	DI.14.	458	453	—	383	331	325	261	262	166
17.	DI.15.	—	—	375	—	334	337	257	—	168
18.	DI.16.	436	433	366	363	340	335	242	240	165
19.	DI.17.	413	403	346	350	300	298	227	223	159
22.	DI.19.	432	438	—	—	318	312	—	233	162
27.	DI.23.	418	421	337	—	—	—	—	210	159
		FEMALES								
15.	DI.13.	434	432	356	357	320	—	—	234	163
20.	—	394	392	325	322	287	283	220	—	151
25.	DI.20.	398	400	331	330	290	289	—	230	152

TABLE 3. Aldebrő-Mocsáros: Males and females

No. of measurements (Martin)	Measurements and indices	9. DI.7. Mat. Male	10. DI.8 Mat. Male	14. DI.12. Ad. Male	15. DI.13. Ad. Fem.	16. DI.14. Ad. Male	19. DI.17. Mat. Male	24. DI.21. Ad. Fem.	25. DI.20. Ad. Fem.	29. DI.25. Sen. Fem.
1.	Glabello-occipital length	187	178	179	180	181	166	176	165	175
1c.	Metopion-occipital length	175	170	175	181	175	160	170	167	172
5.	Basion-nasion length	—	104	103	94	104	93	101	92	98
8.	Maximum breadth of cranium	129	138	133	137	134	145	136	134	142
9.	Minimum frontal breadth	93	101	95	95	94	93	97	93	86
17.	Basion-bregma height	—	134	136	140	130	128	124	122	130
20.	Porion-bregma height	111	113	113	115	112	112	108	110	113
32/1-a.	Frontal angle	48°	50°	55°	52°	50°	49°	46°	52°	50°
38.	Cranial capacity	—	1276	1294	1425	1249	1268	1216	1158	1335
40.	Sup. facial length	—	102	100	91	99	90	96	90	(88)
45.	Bizygomatic breadth	129	135	131	125	(130)	133	128	125	127
46.	Maxillar breadth	—	95	101	(102)	98	98	90	96	—
47.	Total facial height	—	107	107	115	119	126	114	111	—
48.	Upper facial height	(69)	65	65	68	71	71	73	65	67
51.	Orbital breadth	39	39	38	41	40	37	41	39	40
52.	Orbital height	29	29	32	34	32	30	38	33	37
54.	Nasal breadth	—	25	24	23	25	27	24	26	26
55.	Nasal height	51	51	44	49	50	50	50	45	52
62.	Palatal length	48	50	47	—	49	46	42	43	46
63.	Palatal breadth	—	39	39	34	37	38	33	39	—
65.	Bicondylar-diameter	129	128	118	—	(120)	122	113	118	121
66.	Bigonial-diameter	114	110	99	98	90	104	92	101	95
69.	Mental height	—	28	32	32	36	40	30	32	—
70.	Ramus height	62	64	59	69	67	65	62	58	62
71.	Ramus breadth	32	34	36	32	34	34	27	31	34
72.	Total facial angle	—	85°	83°	80°	88°	90°	86°	87°	90°
8:1	Cranial index	68,98	77,53	74,30	76,11	74,03	87,35	77,27	81,21	81,14
17:1	Length-height index	—	75,28	75,98	77,78	71,82	77,11	70,45	73,94	74,29
17:8	Breadth-height index	—	97,10	102,26	102,19	97,01	88,28	91,18	91,04	91,55
9:8	Transvers. frontopar. index	72,09	73,19	71,43	69,34	70,15	64,19	71,32	69,40	60,56
47:45	Facial index	—	79,26	81,68	92,00	(91,54)	94,74	89,06	88,80	—
48:45	Upper facial index	(53,49)	48,15	49,62	54,40	(54,62)	53,38	57,03	52,00	52,76
52:51	Orbital index	74,36	74,36	84,21	82,93	80,00	81,08	92,68	84,62	92,50
54:55	Nasal index	—	49,02	54,55	46,94	48,00	54,00	48,00	57,78	50,00
63:62	Palatal index	—	78,00	82,98	—	75,51	82,61	78,57	90,70	—
	Norma verticalis	Ellip.	Pent.	Pent.	Ovoid	Ovoid	Ovoid	Pent.	Ovoid	Ovoid
	Glabella	4	4	3	2	4	4	2	1	2
	Protuberantia occipitalis externa	2	1	2	1	1	2	0	0	0
	Fossa canina	3	3	3	3	3	2	2	3	4
	Spina nasalis anterior	3	—	2	—	2	—	4	—	—
	Alveolaris prognathia	2	2	3	3	2	2	2	3	1
	Taxon	pn	crA	m-crA-x	n-x	i-x	p-x	i-x	p	p-x

TABLE 4. Aldebrő-Mocsáros: Subadults and infants

No. of measure-ments (Martin)	Measurements and indicis	2. DI.1 Juv.	5. DI.4. Inf.II.	13. DI.11. Inf.II.	21. DI.18. Juv.	28. DI.24. Juv.	30. DI.26. Inf.II.
1.	Glabello-occipital length	167	160	174	168	158	155
5.	Basion-nasion length	91	89	90	93	89	—
8.	Maximum breadth of cranium	136	131	130	136	—	—
9.	Minimum frontal breadth	91	86	89	90	87	83
17.	Basion-regma height	127	125	121	121	115	—
20.	Porion-bregma height	109	103	103	—	—	—
40.	Sup. facial length	88	85	84	85	89	—
45.	Bizygomatic breadth	116	—	117	—	—	—
46.	Maxillar breadth	90	86	84	—	88	78
47.	Total facial height	107	99	100	98	98	83
48.	Upper facial height	62	56	59	61	62	52
51.	Orbital breadth	38	36	36	41	34	32
52.	Orbital height	30	30	30	30	35	30
54.	Nasal breadth	22	21	20	—	22	20
55.	Nasal height	47	40	40	46	48	34
62.	Palatal length	47	41	41	—	—	35
63.	Palatal breadth	40	31	32	30	33	30
65.	Bicondylar-diameter	109	111	110	103	104	90
66.	Bigonial-diameter	90	84	89	93	90	—
69.	Mental height	30	27	28	27	24	24
70.	Ramus height	54	53	52	52	57	42
71.	Ramus breadth	30	30	30	30	23	30
8:1	Cranial index	81,44	81,88	74,71	80,95	—	—
17:1	Length-height index	76,05	78,13	69,54	72,02	72,78	—
17:8	Breadth-height index	93,38	95,42	93,08	88,97	—	—
9:8	Transvers. frontopar. index	66,91	65,65	68,46	66,18	—	—
47:45	Facial index	92,24	—	85,47	—	—	—
48:45	Upper facial index	53,45	—	50,43	—	—	—
52:51	Orbital index	78,95	83,33	83,33	73,17	102,94	93,75
54:55	Nasal index	46,81	52,50	50,00	—	45,83	58,82
63:62	Palatal index	85,11	75,61	78,05	—	—	85,71

TABLE 5. Aldebrő-Mocsáros: Comparison of the anthropological remains of the 10—11th century cemetery

Site of excavation	Period	Author, year of publication	Number of well preserved crania	Distribution of cranial indices					Main taxons
				x—70	70—75	75—80	80—85	85—x	
Szob—Kiserdő	10—11th century	Nemeskéri 1946—1948	Male : 3	—	2	1	—	—	Nordic, East-Europid,
			Fem. : 4	—	—	3	1	—	Turanian
Piliny—Sirány	10—11th century	Lipták 1953	Male : 8	—	1	5	1	1	Nordic
			Fem. : 1	—	—	1	—	—	
Rád	10—11th century	Lipták 1953	Male : 4	—	—	—	2	2	Brachycephal (p),
			Fem. : 2	—	1	1	—	—	Nordic
Csongrád—Felgyő	10—11th century	Bartucz—Farkas 1956	Male : 17	—	4	9	4	—	Turanian, Nordic,
			Fem. : 16	—	5	10	1	—	Cromagnoid
Veszprém—Kálváriadomb	10—11th century	Acsádi—Nemeskéri 1957	Male : 19	—	1	5	13	—	Brachycephal,
			Fem. : 11	—	1	3	7	—	Dinaric, Atlanto-mediterranean
Veszprém—Sashegy	10—11th century	Acsádi—Nemeskéri 1957	Male : 3	—	1	1	1	—	Brachycephal, Nordic
			Fem. : 6	—	1	3	2	—	
Csongrád—Vendelhalom	10—11th century	Lipták 1958	Male : 3	—	—	1	2	—	Nordic, Mediterranean,
			Fem. : 2	—	2	—	—	—	Brachycephal (p)
Sárosd	10—11th century	Acsádi—Nemeskéri 1958	Male : 3	—	1	2	—	—	Brachycephal
			Fem. : 4	—	—	—	3	1	
Székesfehérvár—Kurucdomb	10—11th century	Acsádi—Nemeskéri 1959	Male : 6	—	—	4	2	—	Cromagnoid,
			Fem. : 8	—	—	5	1	2	Brachycephal, Atlanto-mediterranean
Békés—Povádzug	11—12th century	Lipták—Farkas 1967	Male : 25	2	16	5	2	—	Nordic,
			Fem. : 29	—	8	16	5	—	Mediterranean
Aldebrő—Mocsáros	10—11th century	—	Male : 5	1	2	1	—	1	Brachycephal,
			Fem. : 4	—	—	2	2	—	Mediterranean, Nordic

TABLE 6. Aldebrő-Mocsáros:

Fregmentary (not measurable) anthropological material

Grave number	Inventory number	Preservation and morphological characterization of the material	Age Sex
3.	DI.2.	Cranial fragments. Prot. occ. ext.: 4. Mastoid process medium. Mandible very high, pronounced. Gonial region and Prot. mentalis marked.	Sen. Male
4.	DI.3.	Cranial fragments and skeletal remains.	Inf.II. —
6.	DI.5.	Cranial fragments and skeletal remains.	Inf.I. —
7.	DI.6.	Cranial fragments and skeletal remains.	Inf.I. —
8.	DI.30.	Cranial fragments and skeletal remains.	Inf.I. —
12.	DI.10.	Mandible fragments.	(Ad.) Fem.
17.	DI.15.	Cranial fragments. Dolichomorphic. Vertical norm.: ellipsoid. Glabella: 2. Prot. occ. ext.: 2. Mastoid process medium. Forehead steep. Mandible medium high, prot. mentalis very protruding. (The mandible probably does not belong to this cranium.)	(Mat.) Male
18.	DI.16.	Cranial fragments. Dolichomorphic. Vertical norm.: ovoid. Prot. occ. ext.: 2. Fossa canina: 1—2. Alveolar prognathism: 1. Mastoid process medium. Glabella: 3. Mandible medium high. Marked gonion region.	Mat. Male
20.	—	Mandible and well preserved skeleton.	(Ad.) Fem.
22.	DI.19.	Cranial fragments. Prot. occ. ext.: 1. Mastoid process pronounced. Mandible marked, medium high, strongly protruding, marked gonial region.	Mat. Male
27.	DI.23.	Cranial fragments. Prot. occ. ext.: 0. Mastoid process medium.	Male (Mat.)
32.	DI.27.	Cranial fragments.	Inf.I. —
34.	DI.28.	Left ramus mandibulae gracile.	(Mat.) Fem.
35.	DI.29.	Fragmentary skeleton.	Ad. Fem.

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Plate I. Aldebrő-Mocsáros, 10—11th century
Grave 25. p, (Fem.)
Plate II. Aldebrő-Mocsáros, 10—11th century
Grave 19. p—x, (Male)
Plate III. Aldebrő-Mocsáros, 10—11th century
Grave 14. m—crA—x, (Male)
Plate IV. Aldebrő-Mocsáros, 10—11th century
Grave 16. i—x, (Male)
Plate V. Aldebrő-Mocsáros, 10—11th century
Grave 24. i—x, (Fem.)
Plate VI. Aldebrő-Mocsáros, 10—11th century
Grave 10. crA, (Male)

PLATE I

PLATE II

PLATE III

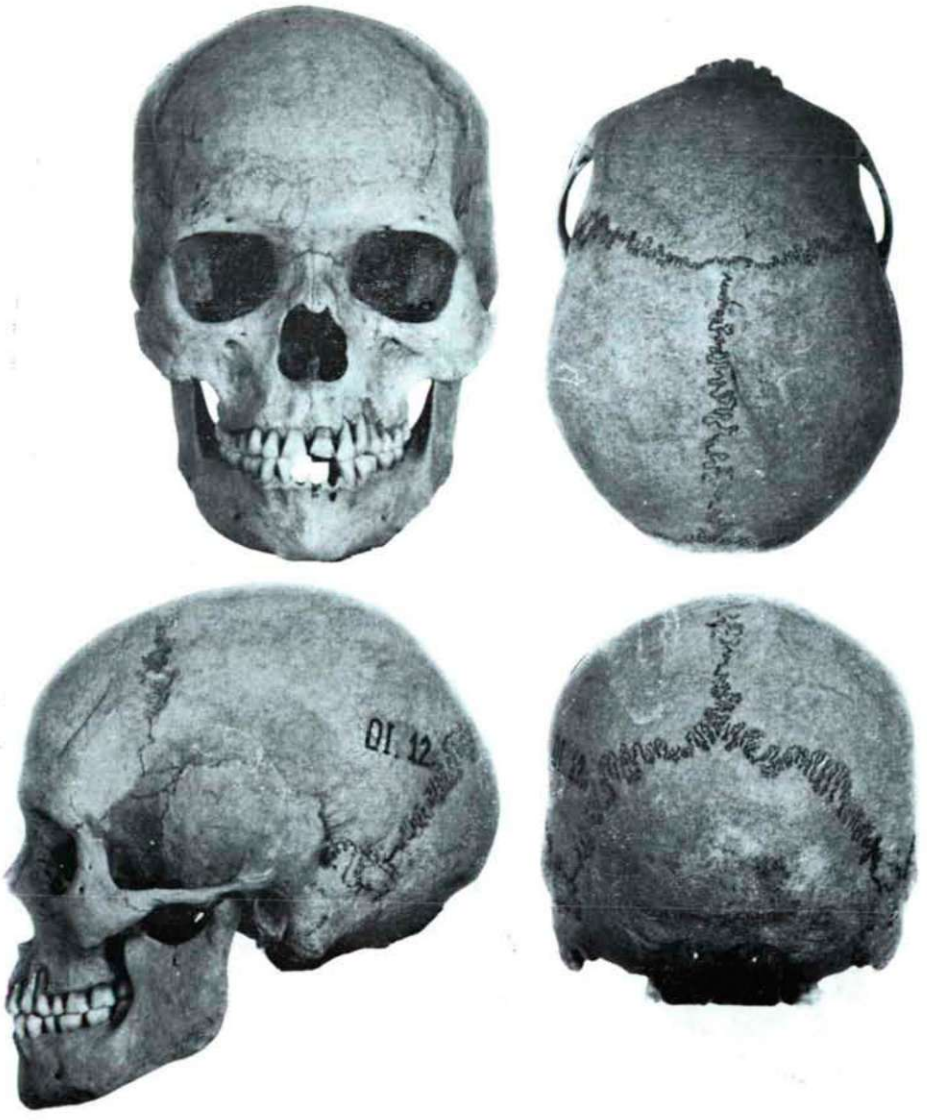


PLATE IV

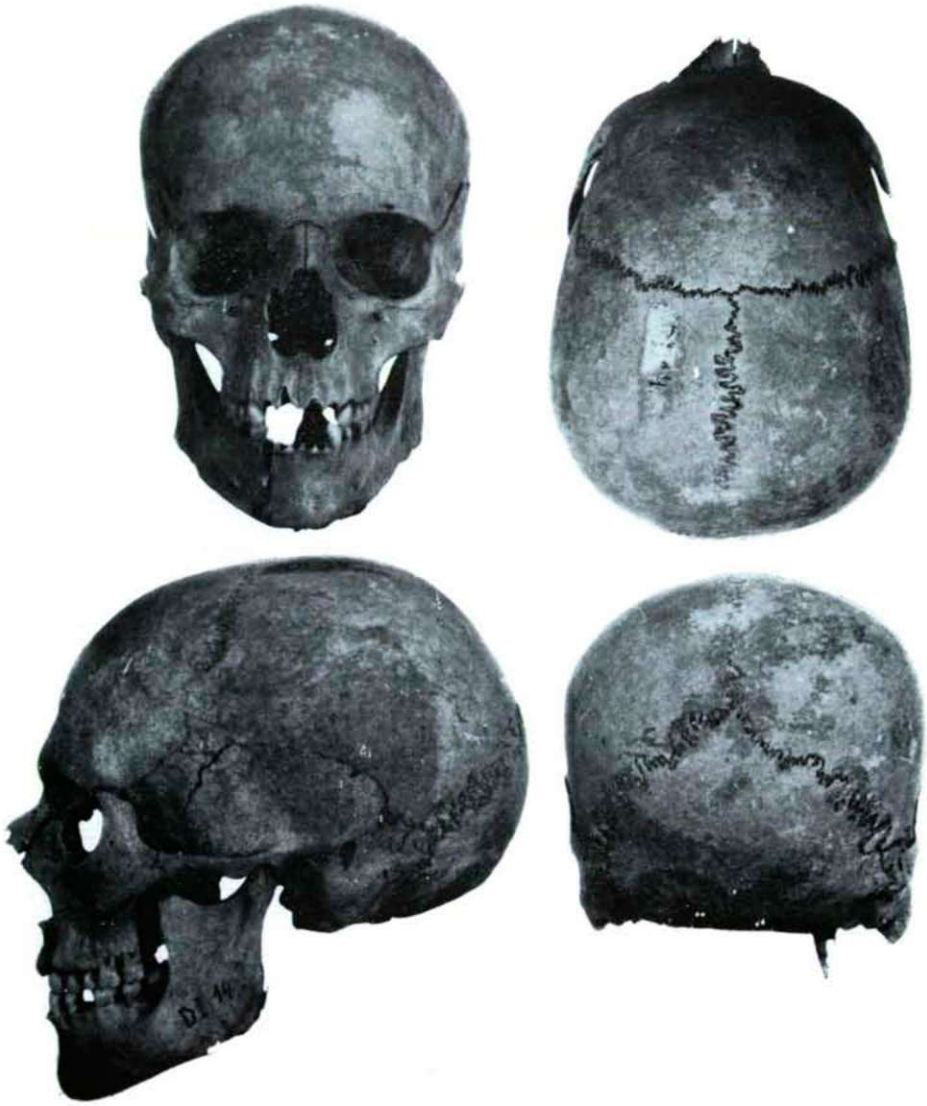
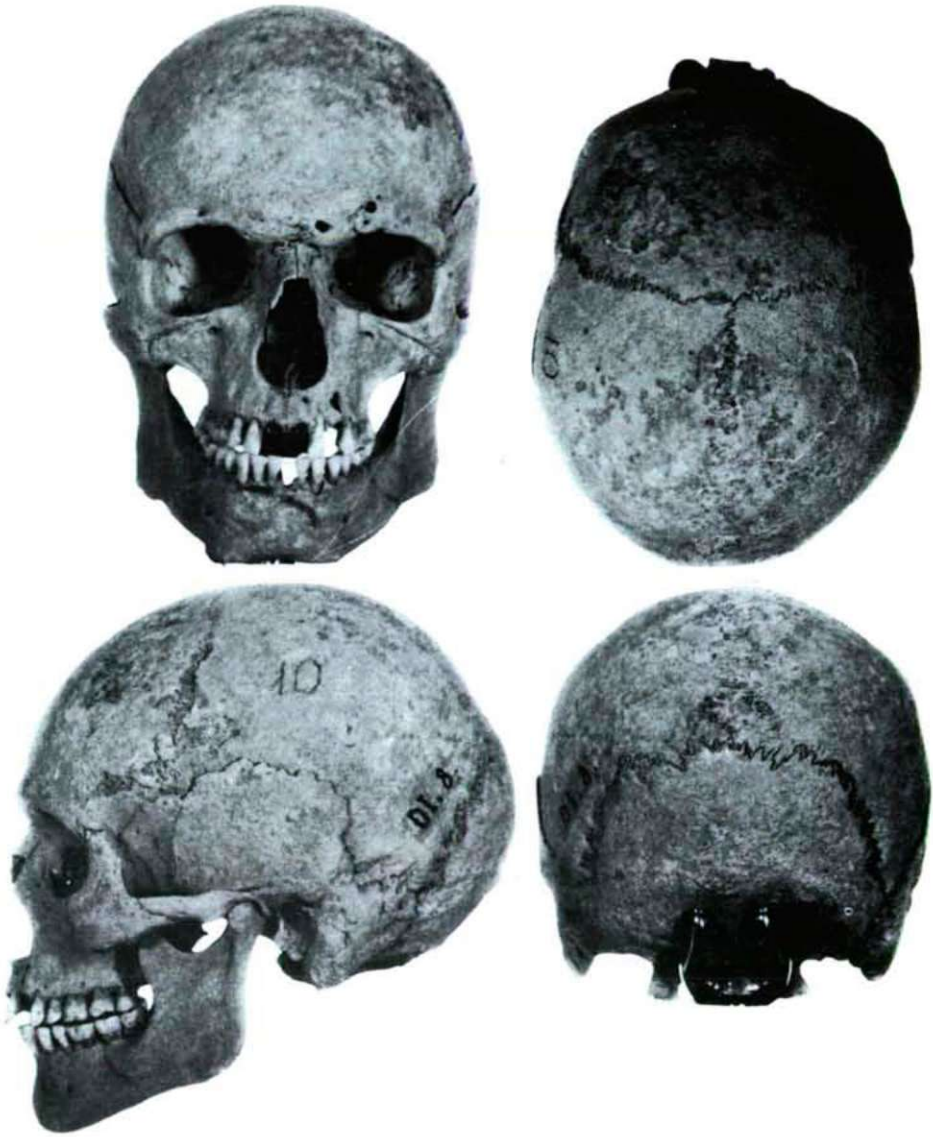


PLATE V

PLATE VI



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